THE PROPOSED GARIEP TRANSFRONTIER CONSERVATION AREA:

Conservation Overlay Evaluation of the South African Section

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EXECUTIVE SUMMARY

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INTRODUCTION

Conservation, the preservation and maintenance of biodiversity, is a prudent goal for the coming decades if we are to reverse the biological impoverishment which is now occurring.

Although there is widespread agreement that conservation areas should be representative of as many levels of biodiversity as possible, the past design of conservation areas has often been a result of the dictates of circumstance, rather than an outcome of deliberate planning. Reserves were often created on lands apparently unsuited for other intensive or profitable uses, and many reserves were created for recreational or other potential uses not primarily associated with biodiversity conservation.

The need for deliberate planning is all the more apparent in the light of the limited financial resources available for land purchases, the ever-increasing competition from other land uses for a diminishing supply of undegraded land suitable for conservation, and the limited infrastructure which is dedicated to conservation. All these considerations emphasise the need for limited resources to be well directed in order to achieve maximum conservation of biodiversity, and to prevent proposed conservation areas from remaining as merely 'paper parks'.

Growing recognition of the decline in biodiversity and the need for conservation planning has led to concerted international action which has resulted in a global conservation policy, contained in the Convention on Biological Diversity of 1992. Within South Africa the response has been formulated in the White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1997). These international and national policies for conservation action define broad strategic conservation priorities.

These strategic policies must be translated into conservation actions at a local level however, which requires specific conservation priorities to be defined for the local scale of conservation action. Defining specific conservation priorities enables relative conservation values to be attached to elements of biodiversity. This valuation facilitates decisions about which elements of biodiversity to conserve first, in situations where for a variety of reasons it is not possible to conserve all of the elements at once.

Although biological conservation priorities can be set for genetic, species, and ecosystem conservation, an integrated conservation approach takes into account the social context within which conservation takes place. The integrated approach therefore sets priorities based on the contribution that conservation could make to human welfare as well as to the goal of maximising biodiversity protection.

Once conservation priorities have been determined, the choice of criteria for assessing the relative conservation values of one or several competing sites will determine the ultimate targets of conservation. Many different criteria, broadly based on the accepted underlying aims and objectives of conservation, have been developed over the decades.

The application of suitable evaluation criteria will allow specific conservation priorities to be defined within the Gariep TFCA.

THE GARIEP TFCA

The Gariep Transfrontier Conservation Area (TFCA) was identified by the Peace Parks Foundation (PPF) as one of seven potential TFCAs in southern Africa. Conservation of the Gariep TFCA would provide protection to the Nama-karoo biome, thereby improving the representativeness of South Africa's reserve network, a national conservation goal.

However, the land in the Gariep TFCA is privately owned and land purchases or contractual agreements with landowners will be required before conservation activity can be carried out. With limited resources available for conservation, and competition between conservation and other activities for a limited supply of land, it is necessary to focus conservation efforts on land with the greatest value to conservation.

Creation of the Gariep TFCA should therefore be the outcome of a deliberate and rational planning process which is based on all relevant available information. Accordingly, the aim of this dissertation is to produce a decision-support instrument which can be used for planning of the Gariep TFCA.

CONSERVATION OVERLAY EVALUATION OF THE GARIEP AREA

The COVER evaluation is a rapid, coarse-filter approach, necessitated by the level of detailed environmental information available. The main source of environmental data for the evaluation was the biophysical and socio-economic information collected for the Feasibility Study (1998). This was supplemented by first-hand knowledge of the Gariep area, a literature review, and interviews with conservationists. The overlay method used for the evaluation is a means of including environmental factors into land use planning. A conservation overlay (COVER) approach was used to evaluate the Gariep area for conservation.

Because an integrated approach to conservation was adopted, both scientific and socio-political criteria were selected for the evaluation. The scientific criteria evaluate biodiversity, while the socio-political criteria evaluate land availability and tourism potential, and the threat to present conservation value.

These criteria were used to evaluate eight environmental factors for conservation. The results of the evaluation are displayed on a series of maps showing the geographic location and extent of the various value zones. The separate maps show the biological conservation value, tourism value, the threat which human activity poses to conservation, and the social cost of conserving the Gariep area.

The biological conservation value map was weighted and combined with the tourism value map to create a map of integrated conservation value. The integrated conservation value map was in turn combined with the threat from human activity map, to create the final composite map (Map 1). This composite displays on a single map the threat and the integrated conservation value.

All but one of the high value zones occur at least partially within 2 km of the Orange River. These high value zones include the hills within the river zone and the riparian vegetation along the Orange River. Two high value ecosystems extend from within the river zone: the three major drainage lines, and the alluvial fans. On the plains at some distance from the river is an isolated high value zone encompassing the forest of *Aloe dichotoma*.

The intermediate value zone includes the non-alluvial topography in the river zone, and hilly areas outside the river zone. The level plains with their associated vegetation are classified as the lowest value.

The highest threat is posed to the high value alluvial fans which open on to the Orange River. The threat is due to the suitability of the alluvial fans for grape farming. An intermediate threat is posed by granite mining in the hilly areas, which includes the high value hills within the 2 km-wide river zone, and the intermediate value hills beyond the river zone. The lowest threat is posed on the level plains, which are suitable for continued stock farming.

The social cost of conservation map is based on the socio-economic value of present land use (Map 2). The map displays the social cost which would be incurred if the present land use was displaced by conservation. A major part of the Gariep area, where stock farming is practiced, can be conserved at a low social cost. In comparison, there is an intermediate to high social cost involved if mining and grape farming are displaced.

Conclusion

The COVER evaluation has identified areas of integrated conservation value that combine ecological, social and economic suitability, all factors which must be considered in realistic and rational decision-making.

The maps are a readily understandable decision-support instrument combining a large amount of evaluated data. They provide information which is intended to guide rather than dictate the process of defining conservation priorities and management strategies for the Gariep TFCA. The maps also provide a foundation and starting point for negotiations with landowners and other interested and affected parties.

The provision of conservation information by an overlay approach gives decision-makers in the conservation as well as the political sphere sufficient information (from the biological and socio-economic perspectives) for them to be able to appreciate the important issues they all face. This information provides impetus and substantiation for the preliminary steps to be taken towards converting the Gariep TFCA from a 'paper park' into a functional reserve.

RECOMMENDATIONS

The following recommendations are made, based on the threat to integrated conservation value map (Map 1):

- **Conservation priorities.** Conservation action should focus on the alluvial fans first, followed by the remainder of the river zone. Thereafter, conservation should expand outwards (towards the south) to include the less threatened and lower value elements of the Gariep area.
- **Management.** The COVER evaluation is an important information source both for deciding on the appropriate location for core protection zones, buffer zones, corridors, and infrastructure and tourist facilities, and for identifying appropriate management strategies for these areas.
- **Public Consultation.** To date, planning of the Gariep TFCA has not involved public participation. The public should be involved as soon as possible. The maps are a familiar format, readily understandable source of information, and should be used in negotiation with landowners and other interested and affected parties.
- **Extending the scope of the evaluation.** If decisions are to be made which include the Namibian section of the proposed Gariep TFCA, the COVER evaluation should not be extrapolated to that section without incorporating additional environmental data. Additional data may result in changes in the conservation values, and indicate alternative conservation priorities or options.

It is hoped that the decision support tools developed by this dissertation will contribute not only to the establishment of the Gariep TFCA, but also to other conservation and tourism land use initiatives in southern Africa.

MAP 1

THREAT TO INTEGRATED CONSERVATION VALUE

GARIEP AREA

Secondary roads

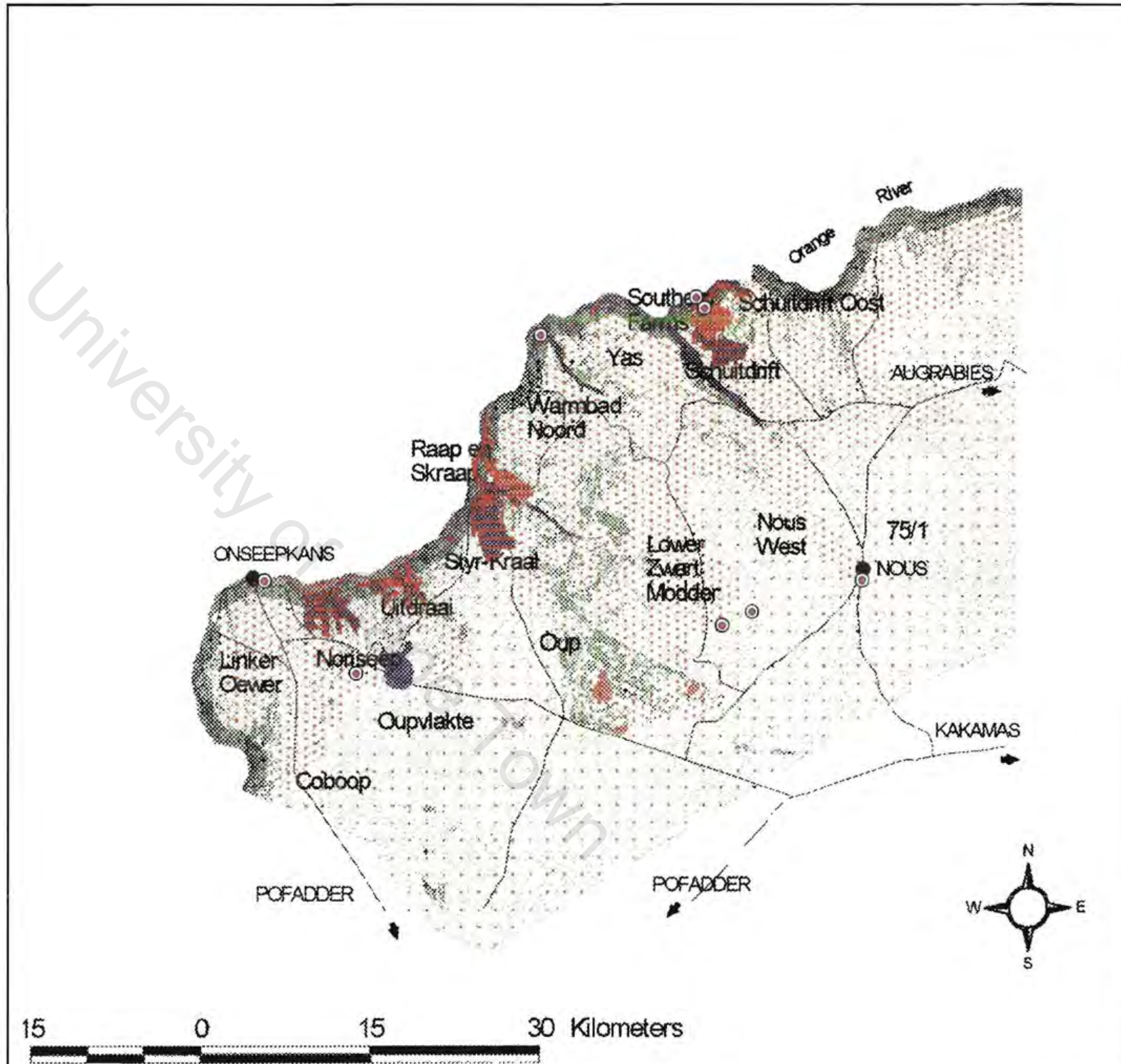
Cultural and historical sites

Styr-kraal Farm names

● ONSEEPKANS Town names

Threat from human activity
- Lower
- Intermediate
- Higher

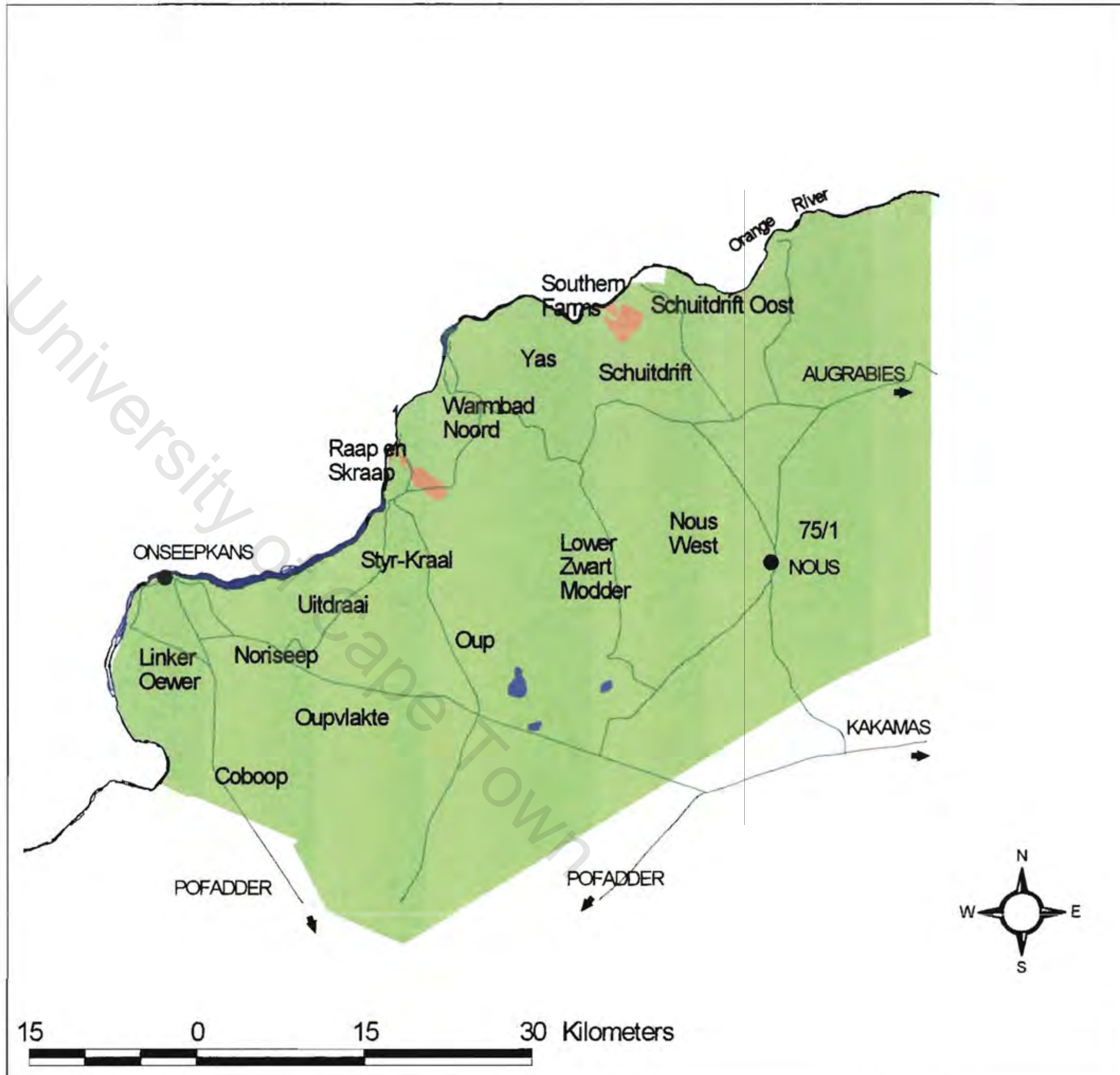
Integrated conservation and tourism value
- Lower
- Intermediate
- Higher
- No value



MAP 2

SOCIAL COST OF CONSERVATION

GARIEP AREA



● ONSEEPKANS Town Names
Styr-Kraal Farm names
Secondary roads
Orange River
Orange River

Social cost of conservation
Higher
Intermediate
Lower

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ABBREVIATIONS

CBD	Convention on Biological Diversity
CNPPA	Commission on National Parks and Protected Areas
COVER	Conservation Overlay
DEAT	Department of Environmental Affairs and Tourism
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
IUCN	World Conservation Union
PPF	Peace Parks Foundation
SANP	South African National Parks
TFCA	Transfrontier Conservation Area
UNEP	United Nations Environment Programme
WRI	World Resources Institute
WWF	Worldwide Fund for Nature

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INTRODUCTION

1. INTRODUCTION

This dissertation draws on the report entitled "Feasibility Study of the Proposed Gariep Transfrontier Conservation Area: Environmental Overview of the South African Section" (Feasibility Study), commissioned by the Peace Parks Foundation (PPF) in 1997.

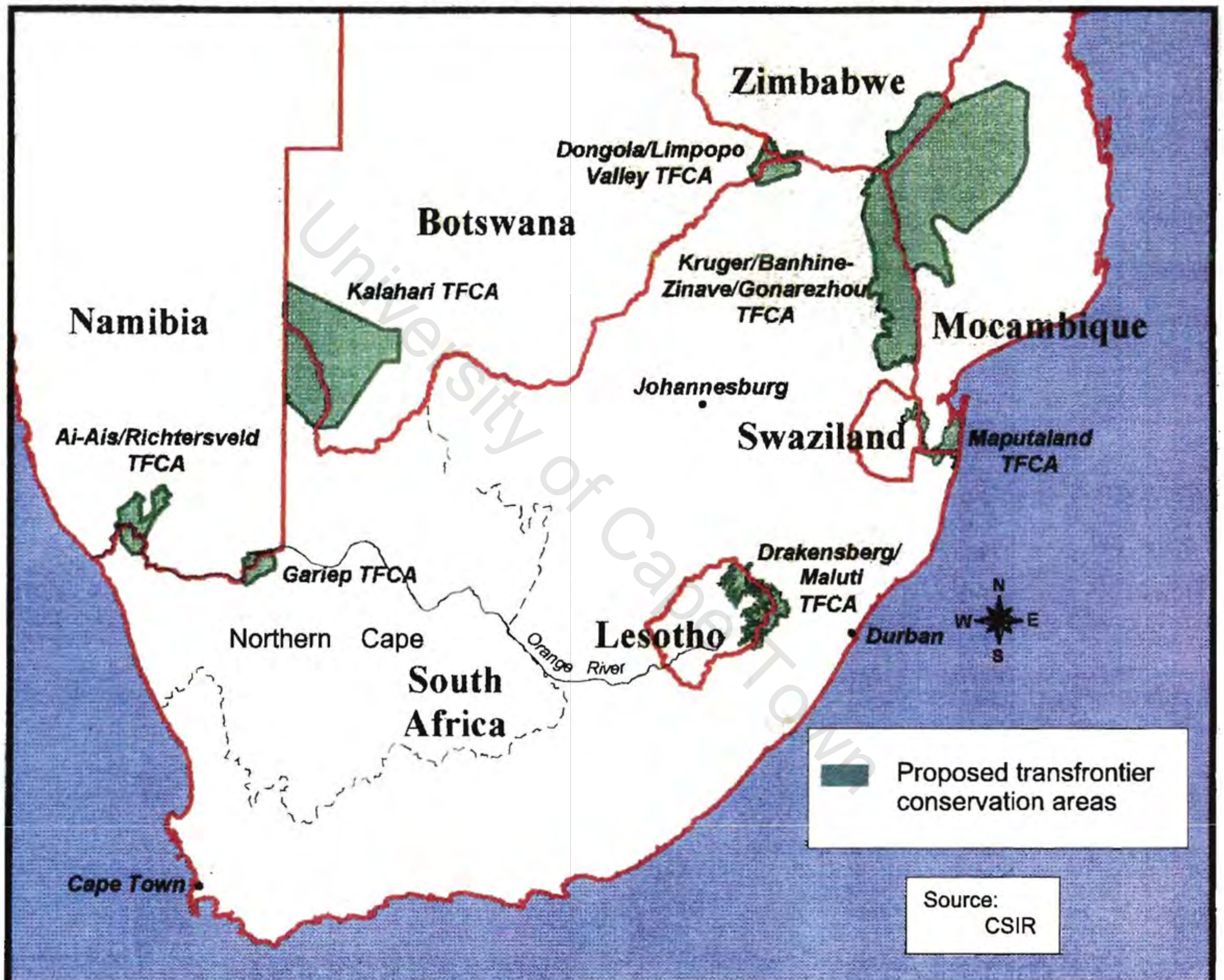
After a brief description of the origin of the proposal to conserve the Gariep Transfrontier Conservation Area (TFCA) and the general background to this dissertation, this chapter will provide the rationale for this study, as well as its aims and objectives, the methodology followed, and the assumptions and limitations.

1.1 ORIGIN OF THIS DISSERTATION

The Peace Parks Foundation was established in February 1997 with the aim of facilitating the establishment of conservation areas that will straddle the international borders between the countries of southern Africa (Hanks, 1997). The concept of TFCAs, or Peace Parks, is not a new one. There are at least 70 protected areas worldwide, involving 65 countries, which are located across international borders (Thorsell, 1990). The background to TFCAs is discussed in more detail in the Feasibility Study.

As a first step towards facilitating the development of Peace Parks in southern Africa, the Peace Parks Foundation identified seven potential TFCAs (Map 1.1). One of these, the Gariep TFCA, straddles the international border between South Africa and Namibia.

MAP 1.1 PROPOSED TRANSFRONTIER CONSERVATION AREAS



Before it was proposed as a TFCA, the South African section had been identified by South African National Parks (SANP) to be a suitable area within which the Nama-karoo biome could receive protection. SANP considered the Gariep area to be suitable for a number of reasons:

- An absence of rural or urban settlements which could be affected by conservation measures;
- The unique occurrence of Bushmanland Nama-karoo close to the Orange River;
- The occurrence of a larger area of Bushmanland Nama-karoo than in other potential conservation areas, and the vegetation was in a reasonable condition;
- The close proximity to Augrabies Falls National Park in the east creates a possibility for linking the Gariep area and the national park; and
- The occurrence of an extremely large population of *Aloe dichotoma* trees.

A preliminary report by the Council for Scientific and Industrial Research (Gelderblom *et al.*, 1997) highlighted a lack of information about the conservation value of the Gariep TFCA. In order to acquire information about the area, the Peace Parks Foundation commissioned two members of the 1997 Masters of Philosophy programme in the Department of Environmental and Geographic Science, University of Cape Town, to investigate the conservation value of the proposed Gariep TFCA and to compile a report on the feasibility of conserving the area.

The feasibility study commenced in November 1997, and a 5-day reconnaissance field trip to the Gariep area in December was followed by a four-week field trip in January-February 1998. Data was collected on the biophysical and socio-economic features of the proposed Gariep TFCA. The final report was submitted to Peace Parks Foundation on 12 June 1998.

1.2 Background to this Dissertation

The Feasibility Study was an environmental overview of the South African section of the proposed Gariep TFCA. The primary aim of the feasibility study was to determine whether conserving the Gariep TFCA was a feasible option. The feasibility study had four objectives, namely to:

- investigate the conservation value of the Gariep area;
- investigate the present and potential land use options for the area;
- investigate the suitability of land for purchase or management by conservation bodies; and
- assess the proposed Gariep TFCA in the context of surrounding socio-economic and environmental factors.

A central theme of the feasibility report was conservation, and the opportunities for tourism which are created by a conservation of the Gariep area. The proposed conservation of the Gariep TFCA is intended to protect a portion of the Nama-karoo, a poorly protected biome in South Africa. Protection of representative sections of the major biomes of the world is a goal of international and South African biodiversity conservation policy (see chapter 2).

A number of the findings and recommendations of the feasibility study are of relevance to this dissertation:

- One of the feasibility study findings was that the Gariep area has conservation value, especially with respect to certain features which are unique, threatened by present land use practices, or underconserved within South Africa.
- The feasibility study also found that any appreciable delay before the land is statutorily protected will increase the risk of further environmental damage occurring within the area, due to expansion of particularly the economically attractive intensive land use activities such as granite mining and irrigated viticulture.
- The feasibility study recommended that in order to convert the Gariep area into a conservation area land must either be purchased or be contracted into a national park by negotiation.
- The feasibility study recommended that land purchases for conservation should include at least some of the features of conservation value.
- The feasibility study highlighted the features with conservation value (Feasibility Study, 1998) that should be conserved in the Gariep TFCA

as well as the individual farms which include these features within their boundaries (Map 1.2).

For the purposes of the feasibility study it was not necessary to map the exact location, geographic extent, and area of overlap between the features. The relative conservation importance of the features was also not established.

This dissertation therefore evaluates the conservation potential of the Gariep TFCA building on the general conservation recommendations of the feasibility study. The intention is that the evaluation serves as a decision-making tool, by providing conservation information in a readily-accessible map format.

1.3 RATIONALE FOR THIS STUDY

The conservation of biological diversity is heavily dependent on protection *in situ*, either in strict nature reserves or in reserves where controlled resource use is managed to ensure the retention of the resource base for the future (Soulè, 1991). Reserves are any *in situ* protection falling within the 6 IUCN categories of protected areas, which range from 'strict nature reserves or wilderness areas' with minimum human disturbance to 'managed resource protected areas' consisting of publicly or privately owned land subject to resource extraction (IUCN/CNPPA, 1990).

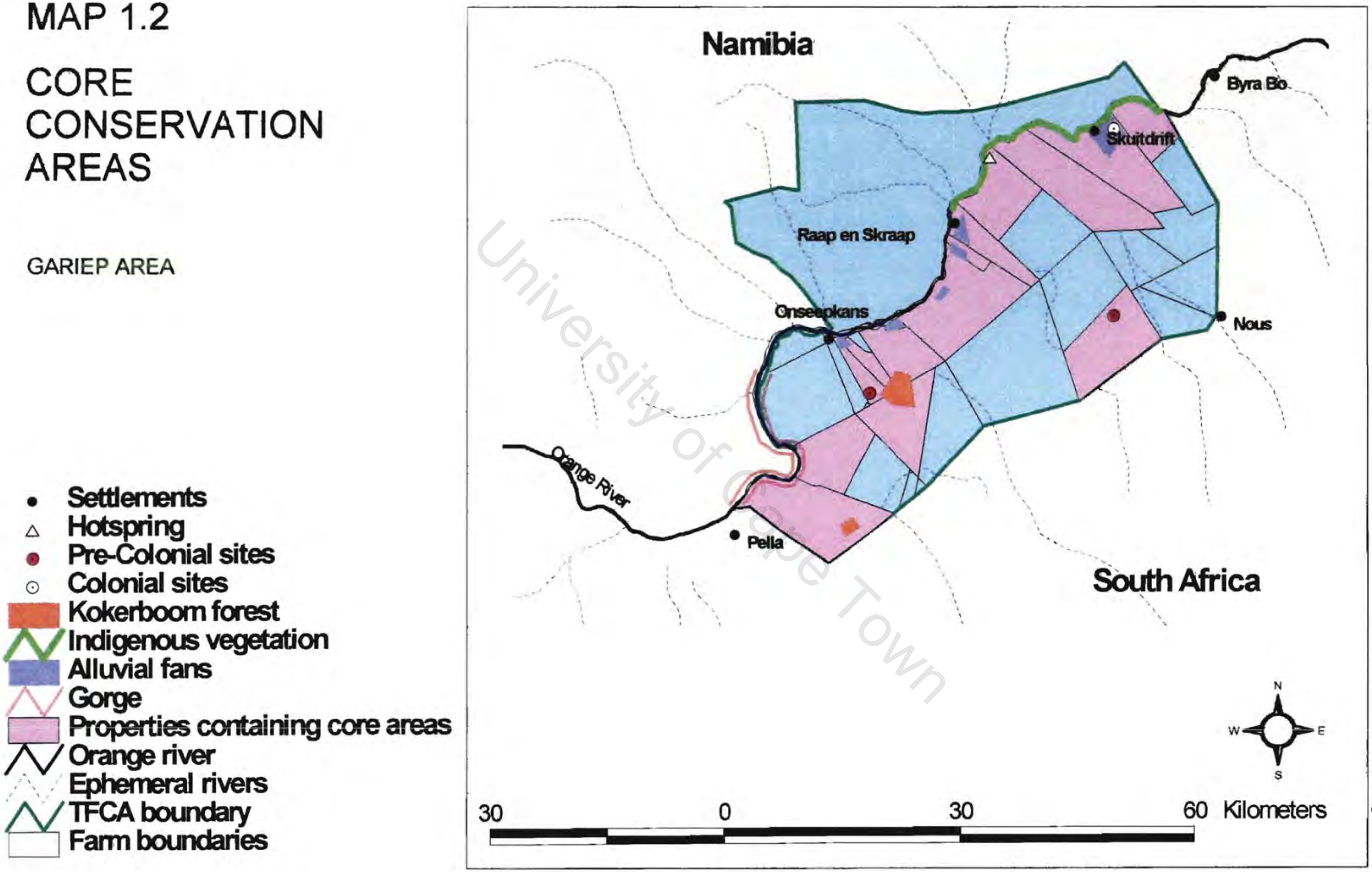
There is widespread agreement that reserves should be representative of as many levels of biodiversity as possible (Miller *et al.*, 1995; White Paper on Conservation and Sustainable Use, 1997; Convention on Biological Diversity, 1992).

Strict reserves should be used to protect those elements of biodiversity which are least able to withstand sustained use, whilst management policies of extractive reserves should be tailored to the needs of the resource, to ensure it is not diminished beyond its regenerative capacity.

MAP 1.2

CORE CONSERVATION AREAS

GARIEP AREA



In order to achieve these goals, the selection of new reserves and the protection levels of reserves should be the outcome of a deliberate and rational planning process.

According to Hollick (1981), rational behaviour entails the selection of alternatives that facilitates the achievement of preselected goals, whilst a rational decision is one which is consistent with the values, alternatives, and information weighed up in the decision-making process. Since rationality is limited by the extent of knowledge and information available, it can be increased by additional relevant information (Hollick, 1981).

Decision-making can be considered as the process of selecting between alternatives. The alternatives will often have differences which can be described in technical terms, and decisions can in theory be based on these technicalities. However, decision-making takes place in a socio-political context, and choosing between alternatives in reality requires that factors be considered in addition to the technical differences between alternatives (Formby, 1990; Ortolano and Shepard, 1995). This realistic paradigm of decision-making implies that information from many sources should be available to the decision-makers, in order to improve the decision.

This dissertation is intended to be a decision support instrument (DEAT, 1998b), providing an additional source of relevant information for use in rational and realistic decision-making surrounding the establishment of the Gariep TFCA.

In the past the design of conservation areas has often been a result of the dictates of circumstance, rather than an outcome of deliberate planning. The history of reserve selection throughout the world reveals that in many cases reserves were selected for reasons not primarily related to representative biodiversity conservation. Pressey (1994) called these *"ad hoc"* reserves, where reservation often took place for reasons of convenience or compromise. In some cases the reserves were "the lands nobody wanted" – for instance, in Australia land unsuited for crops or grazing; in New Zealand, land unsuited for settlement or economic development; high and infertile ground in Britain; or tsetse fly-infested land in Zambia (Pressey, 1994). Reservation of lands has also been done for the scenic and recreation value (Terborgh and Winter, 1983), to attract tourist revenue (Pullan, 1983; Huntley, 1978), protect water catchments (Rebelo and Seigfried, 1990), or to preserve game animals (Pringle, 1982). Within the Nama-karoo biome of South Africa, the past siting of many reserves has been described as opportunistic or arbitrary (Hilton-Taylor and Le Roux, 1989). This supports the view that "the representative (biodiversity) is seldom preserved" (Winks, 1983).

Over 20 years ago Sullivan and Shaffer (1975) referred to this as a "chance process", and warned that if reserve selection continued in this way it could produce a network of reserves inefficient for preserving the full diversity of ecosystems. In other words, the network of reserves could not be representative if reservation was a result of an unplanned process. Five years ago Pressey (1994) repeated the warning, suggesting that avoiding the disadvantages of *ad hoc* reservations would require a more deliberate process of site selection geared towards the conservation needs of particular natural features. A representative reserve network therefore depends on the planned location of new reserves in areas where biodiversity conservation can be maximised. It also depends on reserves being of a size and shape which will give the best practicable opportunity to ensure that the protected biodiversity is maintained in a viable state.

The *ad hoc* reservations of the past have given the world 9832 protected areas, amounting to about 6% of national land areas, or 1,5% of Earth's surface (IUCN, 1994). However, this global network is not representative of global biodiversity. The protection figures for some of the major biomes of South Africa serves as a pertinent example of unequal protection (Table 1.1).

Table 1.1: Protection of some major biomes of South Africa

BIOME	COVERAGE (% of South Africa)	PROPORTION PROTECTED (%)
Savanna	34,24%	10,15%
Grassland	24,26%	2,52%
Nama-karoo	23,5%	2,82%

Source: Low and Rebelo, 1996

In addition to these primarily scientific considerations, the eventual proclamation of a new reserve is dependent on pressure groups, public opinion, political considerations, and pressure from alternative land uses. The need for conservation bodies to put forward cogent reasons for wanting to replace other land uses with conservation is indicated by the increasing competition from other land uses for an ever-decreasing supply of undegraded land. There is also a need for the process of reservation to become more accountable in the light of the high cost of acquisition and subsequent management, and the limited resources available for conserving biodiversity (Pressey, 1994).

The issues identified above imply that the success of the Gariep TFCA as a contribution to the representative reserve network requires an explicit plan. An explicit plan identifying the focal points of the potential conserved area will enhance strategic and rational decision-making about the areas of conservation priority, and provide a timetable for action to optimally conserve the important conservation elements of the area. The plan will also assist in identification of those areas that should be strictly protected, developed for tourism, or be a focus of further scientific study.

A strategic plan showing the location of the various elements of importance to conservation can guide the conservation approach. It may become evident that certain elements can be conserved without adopting a strict conservation approach. Attention and resources can be more productively focused on the more sensitive elements that do require a strict approach, possibly based on ownership by the conservation authority.

In addition, negotiations for purchase of land or for inclusion of land by contract into a contractual national park are likely to be complex and protracted. An explicit and readily understandable plan showing zones of relative conservation importance can form a basis for land purchase or contractual management negotiations between landowners and conservation bodies.

Land purchase will undoubtedly require expenditure of a large sum of money: for example, if the land were to be purchased at R100/ha (which is at the low end of the current land prices in this area), it would cost R20 million to purchase the entire 200 000 ha designated as the proposed Gariep TFCA. If financial resources were unlimited then this would not be an important issue - the entire area could be purchased immediately, at any cost, and the valuable conservation land would automatically be included in the larger area of land purchased. However, not only are financial resources limited for this specific project, but there are many other projects which are also competing for the same limited financial resources. With limited resources for conservation, and competition between conservation and other land uses, compromises will be necessary. Thus by beginning with an explicit plan showing the areas of highest conservation value, the available conservation resources can be used to maximum effect. It is important that financial resources, fund-raising efforts, and conservation infrastructures should be focused on land with the greatest value to conservation, and that the proposed Gariep TFCA should be built around focal selection points of particular conservation value.

A phased approach to land purchases can also be adopted if it is clear which areas are urgently in need of protection, and which areas are not at risk of major or immediate impacts and can therefore be left to be protected at a later date as finances allow.

1.4 Aims and objectives

This study undertakes a conservation evaluation of the Gariep TFCA that is based on an integrated approach which acknowledges, in addition to biological conservation considerations, social, economic, and tourism considerations. All of these considerations are relevant to the development of reserves in areas presently used for other purposes, and should receive the attention of decision-makers.

The aim of this dissertation is to produce a planning instrument which can be used to aid the decision-making process. An integrated conservation evaluation is a decision-support instrument to use in planning for the conservation of the Gariep TFCA. Ideally, a decision-support instrument should provide relevant, accurate and understandable information so that well-informed judgements are facilitated (DEAT, 1998b).

The challenge therefore lies in describing the conservation value of the land by representing the respective values in a spatial way that relates to both the landscape and the environment. Once the geographic location and extent of the various value zones has been identified, the conservation of the area can be more rationally planned. Immediate conservation efforts can be focused on the most valuable land, and particularly on those zones which are at most risk of imminent conversion to land uses that could impact on the environment (Feasibility Study, 1998).

The specific objectives of this study are:

- To translate some of the suitable biophysical, cultural, and socio-economic factors in the Gariep TFCA into factors significant to conservation;
- To rank the phenomena within each factor from higher to lower value from a broad conservation perspective;
- To classify the land within the Gariep TFCA in terms of these values;
- To highlight areas judged to be at most risk of environmental damage from other land uses;
- To produce maps which combine the evaluated data in a format which is both simple and informative, and suitable for use in decision-making; and
- To make some recommendations based on the maps, particularly with regard to the strategic conservation priorities in the Gariep area.

1.5 METHODOLOGY

1.5.1 Data collection

The main source of data for this study was the biophysical and socio-economic information collected for the Feasibility Study (1998). Data were obtained from a range of sources:

- The environmental factors were largely developed from the bio-physical and socio-economic data collected during the feasibility study.
- Additional data forming a basis for the environmental factors were obtained from the preliminary reconnaissance report on the Gariep area prepared for South African National Parks (Appendix 1).

- First-hand knowledge obtained after four weeks on the site was invaluable in informing the selection of significant environmental factors and conservation criteria, and in evaluating the range of phenomena within each environmental factor for relative conservation value.
- Conservation criteria useful in determining conservation value, and approaches to the establishment of conservation areas, were established after a review of the literature.
- Additional information about conservation criteria of importance to South African conservation decision-makers was obtained through personal interviews with people associated with conservation efforts in South Africa.
- Topographic data used for the GIS analysis, including contours and rivers, was obtained in digital format from Chief Directorate Surveys and Land Information.
- Farm boundaries were obtained in digital format from the Deeds Office, Department of Land Affairs.
- An Arcview-based Geographic Information System was used for ranking the environmental factors, and creating the single-factor and composite overlay maps.

1.5.2 Data Analysis

Because methodology is an important part of this study, it will be discussed in detail in chapter 3. However, the method warrants brief discussion here, as an awareness of the methodology adopted provides a background to chapter 2.

In order to depict the Gariep area as a mosaic of conservation values that acknowledge the conservation, tourism, and socio-economic potential of the area, and to derive a strategic conservation plan for the area based on the valuation, this study adopts the overlay approach to land use planning (McHarg, 1969) The 'ecological planning' overlay approach was pioneered by Wallace, McHarg, Roberts and Todd, a firm of Architects, Landscape Architects, Urban and Ecological Planners (Wallace *et al.*, 1971). Essentially the overlay approach is a method to convey in a geographic and qualitative way, through the use of maps, an evaluation of the environmental information collected during the assessment phase.

The overlay approach lends itself to an integrated approach to conservation decision-making by its ability to combine a range of environmental characteristics on one or a few map displays.

1.6 ASSUMPTIONS AND LIMITATIONS OF THIS DISSERTATION

1.6.1 Assumptions

A primary assumption is that the entire South African section of the Gariep TFCA is of sufficient conservation value to warrant further conservation measures being taken.

The area designated for the proposed Gariep TFCA is in many respects an arbitrary area. The boundaries were drawn to follow existing farm boundaries so that an area of Nama-karoo biome was included within the TFCA. It is assumed that these boundaries are unrelated to the natural ecological or other biological or physical boundaries of the area. They also bear little relationship to the areas of maximum conservation concern. This dissertation evaluates the South African section of the Gariep TFCA, including a buffer zone lying on the southern boundary. This is done in order to ensure that any natural features that barely extend into the Gariep TFCA from the south are evaluated as part of the larger Gariep area.

Additionally, it is assumed that it will not be possible to purchase all of the land earmarked for the potential Gariep TFCA, particularly within the short to medium term (less than five years from present). Accordingly it will be necessary to prioritise land purchases.

1.6.2 Limitations

Firstly, the list of environmental factors forming the basis of this study is not the result of an exhaustive environmental assessment. The Feasibility Study was an environmental overview which highlighted the environmental features of the area sufficiently for them to inform the decision-making about the conservation future of the area. For this reason, comprehensive field inventories of species or other biodiversity elements were not compiled.

Neither were the biophysical features within the area surveyed in detail. In addition, there is a general absence of information available about the Gariep TFCA (Gelderblom *et al.*, 1997).

This general paucity of biological information limited the selection of factors. Accordingly, this dissertation generalises the basic unit of diversity, and adopts an ecosystem and habitat approach as a coarse-filter assessment of the biological conservation value. A 'fine-filter' approach would make use of detailed species inventories and species distributions for assessing conservation value of the area. However, it has been estimated that 85-90% of species can be protected by the 'coarse-filter', without having to inventory or plan reserves specifically for these species (Scott *et al.*, 1992).

Secondly, the selection of environmental factors was subjective, and based on personal familiarity with the Gariep area as well as the data and findings of the Feasibility Study (1998). In an attempt to limit subjectivity, factors for the biological conservation evaluation were selected after discussion with conservation staff from SANP. The views of academic conservation biologists were also canvassed, and these differed in some respects from those of SANP staff. It was evident that a panel composed of SANP staff and academic conservation biologists could have arrived at a slightly different set of factors. Time constraints, however, prevented factor selection by panel evaluation.

Thirdly, the design and management of the reserve, its optimal size and shape and whether or not there should be corridors or buffer zones, are questions beyond the scope of this dissertation. Field verification of specific sites of conservation value will therefore be essential before such design decisions are made.

1.7 STRUCTURE OF THIS DISSERTATION

This introductory chapter has sketched the origins of the proposal to conserve the Gariep TFCA, and the background to the dissertation. The rationale, aims and objectives, methodology, and assumptions and limitations have also been discussed.

Chapter 2 will explore international and national biodiversity conservation policies, and the central themes of biodiversity and conservation. The selection criteria used for developing conservation areas will also be discussed, and used to develop a set of criteria for measuring the conservation, tourism, and socio-economic value of the land within the Gariep TFCA.

Chapter 3 will describe the overlay procedure of land use planning, while Chapter 4 will apply the overlay procedure to evaluate the Gariep TFCA for its conservation value, making use of the criteria selected in Chapter 2. The environmental phenomena within each factor will be ranked into relative values from most to least conservation importance. The Gariep TFCA will then be defined as zones of relative conservation value, and these will be displayed on maps.

A general discussion of the maps will follow in Chapter 5, and Chapter 6 will conclude and make recommendations with respect to the conservation priorities within the Gariep TFCA.

DEFINING CONSERVATION PRIORITIES AND CRITERIA

2. DEFINING CONSERVATION PRIORITIES AND CRITERIA

This chapter begins with the definition of the central themes of this dissertation, conservation and biodiversity. It moves on to outline the international and national biodiversity conservation policy. This is followed by an examination of the conservation approaches that can be adopted, and the options available for setting conservation priorities. The chapter concludes with an examination of the possible criteria which can be used in selecting areas for conservation.

2.1 DEFINING THE CONCEPTS CONSERVATION AND BIODIVERSITY

2.1.1 Conservation

This dissertation uses the term "conservation" in the narrow sense of the word, namely the preservation and maintenance of some or all the components of biodiversity. More broadly, conservation refers to both preservation and sustainable use of biodiversity (Heywood and Baste, 1995).

2.1.2 Biodiversity

Biodiversity is a contraction of the term 'biological diversity', and refers to the diversity of 'life'. For most scientific purposes, biodiversity is defined taxonomically on the basis of the evolutionary relatedness of organisms. For conservation purposes however, biodiversity is a classification of organisms based on biospatial hierarchy (Soulé, 1991; Primack, 1993). This is because, in practice, most conservation strategies are based firstly on geographically determined *in situ* conservation goals. Thus the conservation biodiversity hierarchy relates to geographic place, not evolutionary relationship.

The multifaceted nature of the biodiversity continuum is recognised in the definition adopted by the Convention on Biological Diversity (CBD, 1992, Article 2):

> *"the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems"*

The goal of biodiversity conservation is to reverse the process of biotic impoverishment of ecological, species and genetic diversity. (see Figure 2.1). The three levels of biodiversity can be described as follows:

2.1.2.1 Ecological diversity

Of the three biodiversity concepts, ecological diversity can be regarded as the concept commanding the highest level of importance, since all species exist and function as part of a wider environment. All species occupy a particular niche in an ecosystem and interact with other species in a web of interdependent relationships. An ecosystem is more of a conceptual entity than is either a species or a gene. Ecosystems do not exist as discrete units, but intergrade in complex ways so that any ecosystem is really part of a continuum. Definition of ecosystems is thus scale-dependent, with an ecosystem definable on a large scale comprising a number of smaller-scaled ecosystems. Terms such as landscape, ecosystem, habitat, and community are not objectively definable, making it difficult to estimate the diversity of these elements of biodiversity, or to define and delimit them.

Protection at ecosystem level safeguards the components of this level – habitats, communities, species, populations, and genes – as well as the ecological and evolutionary processes and interactions, and the human cultural activities historically associated with the ecosystems.

2.1.2.2 Species diversity

Species form the taxonomic starting point for classification of living organisms. Species are also the central concept of biodiversity, and can be defined as populations of phenotypically (the observed traits of an organism, resulting from the interaction between the genetic makeup of the organism and its environment) similar organisms that routinely exchange genes under natural conditions (Wilson, 1992). Species provide the main point of reference in most attempts to quantify and assess the magnitude of ecological systems at other levels. At the species level of biodiversity, biodiversity conservation has frequently focused on endangered species, endemic species, or locales with a highly diverse complement of species, such as the Cape Floristic Region.

Species-based approaches to conservation focus on *in situ* conservation of viable populations of the species, such as, for example the Mountain Gorilla population of Rwanda, or Addo Elephant population of the Eastern Cape. This is because the viability of a species in the wild is dependent on the existence of a viable population of individuals which interbreed. Populations may vary from a handful of individuals to many millions of individuals of the same species. Thus conserving a particular species requires conservation of at least one viable population of that species. This emphasizes the interlinked nature of these biodiversity levels, with species existing as viable populations within a suitable ecosystem (see Figure 2.1).

2.1.2.3 Genetic diversity

Genetic diversity is a small but fundamental unit of biodiversity. The diversity of the genetic material is the underlying reason for the variability within and between species, and can be viewed at three levels: diversity between individuals within one population; diversity between populations within one species; and diversity between different species. Genetic variability provides the resilience and adaptability, fitness and evolutionary flexibility that are required for the survival of organisms. Genetic fitness is a particularly important survival mechanism for the rapidly changing environmental conditions of the present.

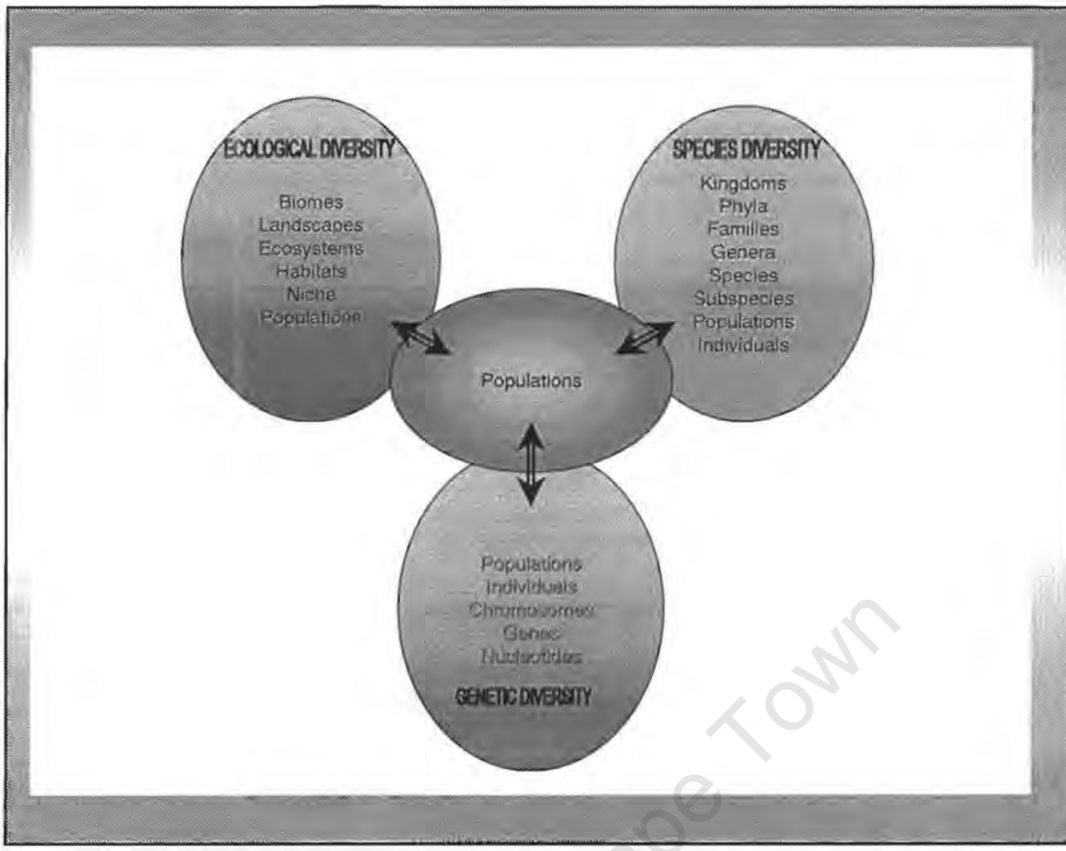


Figure 2.1: The composition and levels of biodiversity

2.2 Loss of Biodiversity

The diversity of species found on Earth has been increasing since life originated over 600 million years ago. The steady rise in diversity has been interrupted by five episodes of mass extinction in the past 440 million years (Wilson, 1992). It took tens of millions of years after each mass extinction for biological diversity to recover to pre-extinction levels.

Ninety-nine percent of all species that ever lived are now extinct. The survivors, who managed to evade the environmental upheavals of geological history, are with us today – the modern flora and fauna, including mankind, that we see around us.

Past extinction rates are estimated from the fossil record to be rather low, of the order of 1 species per million years (the background rate). In contrast, the current observed rate of extinction of birds and mammals is running at 100-1000 times the background rate (Raup, 1978). When one considers that humanity only originated less than 1 million years ago, it becomes clear that the present impoverishment of biological diversity will not be reversed in a time scale that makes any sense to humankind.

Measures for the conservation of biodiversity are a response to this global loss of biodiversity, which is occurring at such an unprecedented rate that:

> *'The sixth great extinction spasm of geological time is upon us, grace of mankind.'* (Wilson, 1992).

Whereas the previous five great extinctions had no human witnesses and were a result of diverse causes, the sixth extinction spasm that Earth is currently experiencing can be attributed to human activity. The causes of present extinctions have been categorised as habitat destruction, habitat fragmentation, habitat degradation, the introduction of exotic species, the increased spread of disease, and the overexploitation of many species for human use (Primack, 1993).

While the events described above are viewed as the *proximate* causes of extinctions, they are in their turn a result of the overwhelming presence of humans. Humans appropriate 20-40% of the solar energy which is captured as organic material by land plants, and extend their influence into every habitat on Earth (Vitousek *et al.*, 1986 – Wilson). The anthropogenic sources of extinction have been described as follows (WRI/IUCN/UNEP, 1992):

- Unsustainably high rates of population growth and natural resource consumption;
- Steadily narrowing spectrum of traded products from agriculture to forestry, and introduction of exotic species associated with agriculture, forestry and fisheries;
- Economic systems and policies that fail to value the environment and its resources;
- Inequity in ownership and access to natural resources, including the benefits from use and conservation of biodiversity;
- Inadequate knowledge and inefficient use of information; and
- Legal and institutional systems that promote unsustainable exploitation.

Over the past decades, growing recognition of the magnitude and extent of the destruction of biodiversity has led the world community to take concerted action to ensure the conservation of biodiversity at all levels, from genetic to ecosystem level.

2.3 Policy Responses to Loss of Biodiversity

Policies for biodiversity conservation originate on two interlinking levels, the international and the national (Figure 2.2).

2.3.1 International Response: The Convention on Biological Diversity

Following three years of hard bargaining, the Convention on Biological Diversity was adopted and opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development in Rio de Janeiro, and entered into force in December 1993 with the thirtieth ratification.

Prior to the adoption of the Convention on Biological Diversity, the sectoral and regional nature of international treaties dealing with species and ecosystem protection led to considerable gaps in coverage. Firstly, regional treaties are limited to certain parts of the world. Secondly, the treaties generally vary widely in the substance of their obligations, as well as in the effectiveness of the mechanisms and institutions that they establish. Thirdly, no mechanisms existed for the co-ordination of actions taken under the existing conventions. Consequently the goal of the new treaty was to establish general obligations for the preservation of biodiversity and to provide a coherent framework for action in the future.

The Convention on Biological Diversity recognises that biodiversity is fast decreasing and that it should be conserved for both ecocentric and anthropocentric reasons. The Preamble recognises the "intrinsic value" of biodiversity, and that it should be preserved for the continuation of evolution and the maintenance of the life-supporting systems of the biosphere. Moreover, biodiversity must be conserved for humankind because of its ecological, educational, cultural, recreational and aesthetic values for present and future generations. For all these reasons, the Preamble affirms that the conservation of biodiversity is a 'common concern of humankind'.

The Convention has three objectives:

- Conservation of biodiversity;
- Sustainable use of biological resources; and
- Fair and equitable sharing of benefits arising from the use of genetic resources.

The Convention places particular emphasis on *in situ* conservation, and maintenance of viable populations of species in their natural surroundings (article 8). The Convention requires Parties to adopt national strategies, plans or programmes for the conservation and sustainable use of biodiversity, and to integrate conservation and sustainable use of biodiversity into relevant sectoral or cross-sectoral plans, programmes or policies (article 6). Parties must identify the components of biodiversity important for its conservation and sustainable use, monitor such components, and identify processes and activities which are likely to have significant adverse impacts on biodiversity (article 7).

2.3.2 National Response: South African National Biodiversity Policy

South Africa acceded to the Convention on Biological Diversity on 2 November 1995, and in so doing accepted the objectives of the treaty and the obligations that it imposed.

In response tc the Convention, in particular to article 6, South Africa has prepared a policy regarding biodiversity conservation, which is contained in the White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (White Paper, 1997).

The South African Biological Diversity Policy has six goals :

Goal 1. To **conserve** the **diversity** of landscapes, ecosystems, habitats, communities, populations, species, and genes in South Africa.

Goal 2. To **use** biological resources **sustainably** and minimise adverse impacts on biological diversity.

Goal 3. To **ensure** that **benefits** derived from the use and development of South Africa's genetic resources **serve national interests**.

Goal 4. To **expand** the **human capacity** to conserve biodiversity, to manage its use, and to address factors threatening it.

Goal 5. To **create conditions and incentives** that support the conservation and sustainable use of biodiversity.

Goal 6. To **promote** the conservation and sustainable use of biodiversity **at the international level**.

(White Paper, 1997)

For the purpose of this study, the conservation of diversity (Goal 1) is of particular relevance. The government has recognised that South Africa's protected area system is an asset of unsurpassed value, which in addition to conserving biodiversity also generates substantial economic benefits through tourism (White Paper, 1997: objective 1.3).

The following section expands on this conservation goal. This will provide a background to the reasoning that led to the identification of the Gariep area as a potential conservation area.

Policy aimed at conservation of diversity in South Africa

In order to achieve the conservation of diversity, the first goal of South Africa's Biological Diversity Policy, the policy recognises that:

- it is necessary to identify the components of biodiversity which are important for conservation and sustainable use of biodiversity. This includes relatively "pristine" ecosystems and habitats, and those that are under particular threat, unique, or representative of or associated with key biological or other life-supporting processes (White Paper, 1997: objective 1.1).
- certain of South Africa's biomes are inadequately protected, and South Africa does not yet have a representative and effective system of protected areas. A conservation objective of primary importance is the need to create a planned network of representative protected areas in order to achieve at least 10% representation of each habitat and ecosystem type within each of the seven biomes (White Paper, 1997: objective 1.3).

Planning of conservation priorities at international and national policy level is a means of deciding in strategic global terms what needs to be conserved, and hence *where* conservation areas need to be located within broadly defined geographic areas. In a world of competing land uses and limited conservation funding, priorities must be established for conserving biodiversity. Geographic priority-setting at a global or wide regional scale is evident in the conservation approaches of a number of authors, for example, the 'hotspots' approach (Myers, 1988, 1990), the 'megadiversity countries' approach (Mittermeier and Werner, 1990), and the conservation/threat approach (Dinerstein and Wikramanayake, 1993).

While strategic planning takes place on an international and national policy level, the conservation and protection of biodiversity happens on a bioregional and local level (Figure 2.2). Conservation must address issues on a geographic scale that is consistent with the objectives sought. Bioregional and local planning and management should therefore be responsive to the dynamic features of ecosystems, including the human societies that are a part of these ecosystems.

In addition, biodiversity management should be an iterative process capable of adapting to unfolding circumstances, responding to and learning from past experience and influencing existing and new policies both at a global and a national level (Figure 2.2) (Miller *et al.*, 1995). Thus management experience should be used to continually adjust the conservation priorities, targets, and tactics.

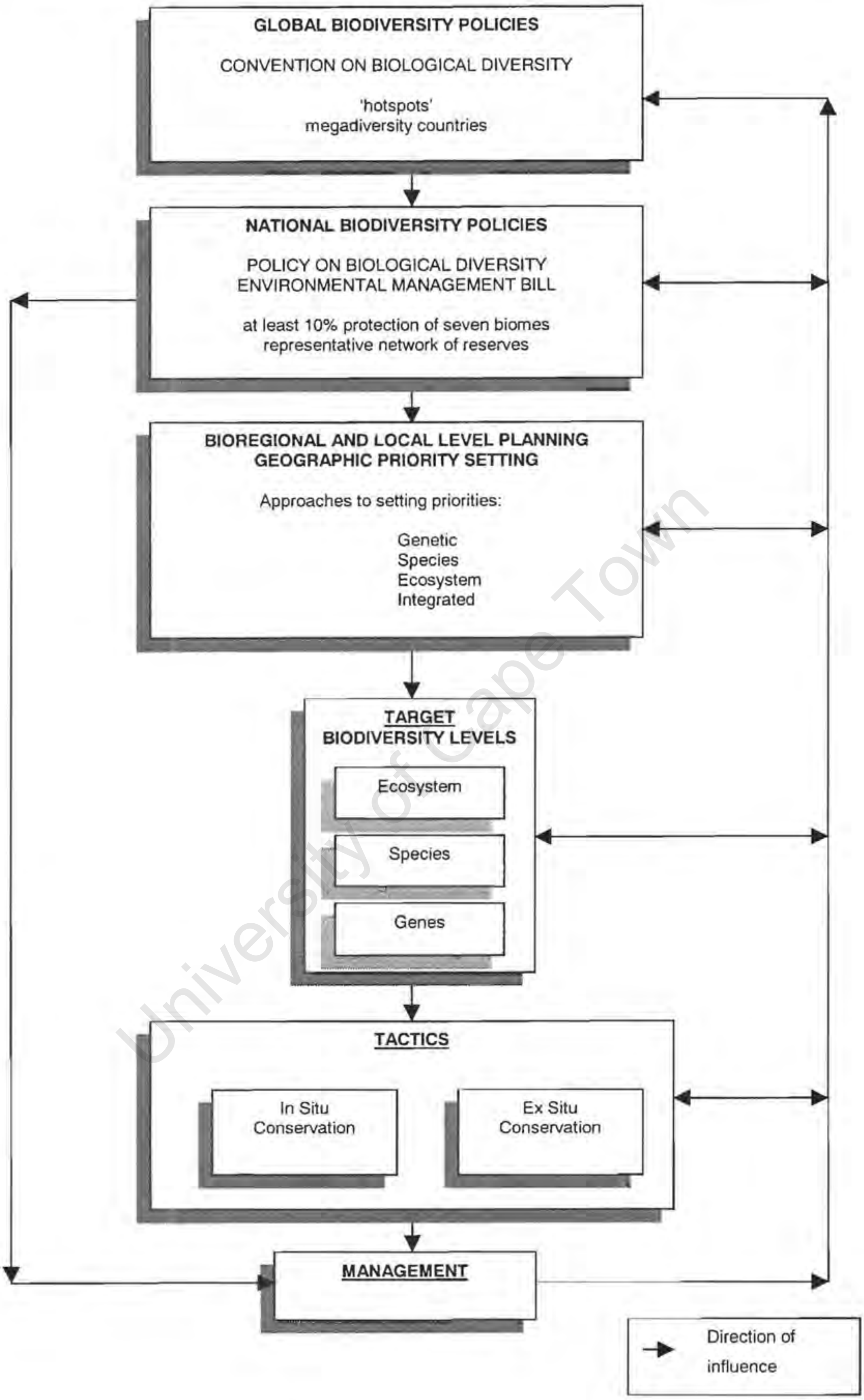


Figure 2.2: Levels of conservation planning and management

2.4 SETTING GEOGRAPHIC PRIORITIES FOR CONSERVATION

Defining conservation priorities on a bioregional or local geographic scale requires specific identification of *what* needs to be conserved, from within the range of biodiversity occurring in areas prioritised at international and national levels, and *how* best to conserve it (Figure 2.2). At this geographic scale, decisions must be made about the relative conservation value of biodiversity at the genetic, species, and ecosystem levels. A method of priority setting is therefore required which will enable the most important biodiversity elements to be identified for protection, in line with global and national policies. Because the resources for conservation are limited, priority setting enables allocation of resources in a way that maximises the amount of biodiversity which is conserved.

Many approaches have emerged over the past decades for setting geographic priorities for a wide range of conservation objectives. Although no single method fits all conservation objectives, four groups of methods have been recognised (Miller *et al.*, 1995). Three of the method groups rely chiefly on biological information. The fourth, integrative, group relies on social, economic, and cultural information in addition to biological information.

2.4.1 Genetically based priority setting

The great diversity between individuals of a species, and between species, and the fitness of individuals of a species, is ultimately based on genetic variability. Genetic priority setting has traditionally focused on domesticated plants, the diversity in these cases being stored *ex situ* in seed banks. However, the development of sophisticated molecular genetic and reproductive biology techniques now makes it possible to use genetic priority setting in the conservation of species or populations facing inbreeding and a narrowing genetic base, or an outbreak of disease (such as the tuberculosis epidemic amongst African Buffalo in South Africa).

2.4.2 Species based priority setting

This is the most common method of priority setting. The species is a well-defined and visible unit of biodiversity, making it a natural focus for conservation efforts. Species-based priorities often involve rare or endangered species, or habitats containing endemic species or high levels of species diversity. The drawback of species-based conservation is its emphasis on the value of individual species at the expense of conservation of ecosystems. This may result in numerous habitats and ecosystems being given low priority merely because they do not harbour species considered to be rare, endangered, or endemic. The advantage, however, is that individual species can become recognisable conservation icons for rallying public and political support. Conservation of the panda, tiger, rhino, or Brenton Blue butterfly are well known examples of the species-based approach to conservation.

A second species-based approach targets the habitats which are particularly important for certain species, such as the 234 centres of plant diversity recognised as having exceptional levels of species richness and endemism (WWF and IUCN, 1994-5). Of these, seven are located in southern Africa, including the Cape Floristic Region which is a conservation priority of the Cape Peninsula National Park.

2.4.3 Ecosystem based priority setting

The value of targeting an ecosystem for conservation is that it automatically extends protection to the diversity of species and genes that make up the multiple relationships of the ecosystem. Whereas conservation of a particular species may give less priority to conservation of the ecosystem, conservation of the ecosystem ensures that the species is also conserved. Ecosystem-based conservation can ensure protection not only of species, but also of vital ecological processes and habitats essential to biodiversity conservation that a species-based approach may overlook. In addition, when there is little information about species rarity or endemism, or species distributions are unknown (as is the case for the Gariep TFCA), an ecosystem-based approach is the only way to address conservation priorities. Since habitat degradation is a primary proximate cause of declining biodiversity levels, priority setting focusing on ecosystems, and thus on habitats, represents the most direct and holistic response for limiting the effects of habitat degradation. This is also illustrated in the Gariep TFCA where riparian habitat degradation is occurring due to invasive plant species, and where protection of the riparian ecosystems will protect all the elements of biodiversity from further degradation.

A drawback of the ecosystem approach is that prioritising ecosystems may fail to include all rare or endemic species, or species with localised distributions, unless they happen to be a part of the priority ecosystem.

Adoption of any of these methods of priority-setting in isolation is not the most efficient way to ensure maximum biodiversity conservation. Concentrating on genetic diversity, in addition to being reliant on technically sophisticated methods, will tend to neglect the value of functioning ecosystems; a focus on species likewise runs the risk of neglecting the importance of ecosystems and habitats; and a focus on ecosystems may neglect rare or narrowly distributed species falling beyond the ecosystem's borders. Therefore the best approach to biodiversity conservation will be one which sets priorities that take account of all levels of the biodiversity hierarchy.

2.4.4 Integrated approach for establishing priorities

An integrated approach takes cognisance of the fact that setting conservation priorities is a subjective exercise and that conservation takes place in the same areas as are inhabited by humans. The approach therefore makes use of social, political, cultural, and economic priority setting in addition to the scientific or biologically-based priority setting described in the three foregoing categories.

The integrated approach sets priorities so that biodiversity conservation is valued for its contribution to human welfare as well as its contribution to the goal of maximising biodiversity protection. While this approach may result in biodiversity protection being undervalued relative to the social or other values attached to the biodiversity, the non-biological values may strengthen the social and political significance and viability of protecting the biodiversity. For example, an area with significant tourism potential in addition to its biodiversity value may be more politically and socially viable than a region valued purely for its biodiversity potential (Feasibility Study, 1998).

This dissertation adopts an integrated approach to determine the conservation values within the Gariep TFCA, by evaluating factors indicative of tourism and socio-economic potential, as well as factors indicative of biodiversity. The priority setting targets both the species level of biodiversity (for example, the *Aloe dichotoma* population) and the ecosystem level (for example, riparian ecosystem, alluvial fan ecosystem), within the limits imposed by the available data.

2.5 Practical Responses to the Loss of Biodiversity

2.5.1 Conservation Tactics

There are a number of different approaches to conserving biodiversity (Figure 2.2), and the approach adopted tends to be closely related to the level of biodiversity targeted for protection, as well as to the goal of the conservation effort. These approaches, the tactics for dealing with the crisis in biotic diversity (Soulé, 1991), fall into two categories (Miller *et al.*, 1995).

1. ***In situ* conservation** approaches target all levels of the biodiversity hierarchy, and aim at on site protection, in the wild. *In situ* conservation occurs both within and outside protected areas. Conservation can take place in wilderness areas and national parks managed for protection of genetic, species, and ecosystem diversity, as well as in agricultural or forestry plantations managed for protection of genetic diversity, and resource reserves managed for sustainable use. Restoration and rehabilitation of ecological processes and ecosystems are an additional facet of the *in situ* approach.

   An example of a regional *in situ* conservation approach is the Peace Parks Foundation initiative to foster the creation of transfrontier conservation areas in order to protect ecosystems and regional biodiversity in contiguous areas that cross international frontiers (Feasibility Study, 1998). If a common, shared ecosystem is divided by an international frontier, rational management at this biodiversity level will require a joint effort by the various nations. A shared ecosystem that is not managed jointly might well lead to strife, as well as to the degradation of the entire ecosystem due to actions taken in one of the sharing countries (Westing, 1993).

2. ***Ex situ* conservation** approaches remove organisms from their habitat for

storage, breeding, or rescue. The *ex situ* approach targets genetic and species levels of the biodiversity hierarchy, particularly in response to habitat loss or other threats to the continued survival of the organism. Examples of living *ex situ* conservation are zoological or botanical gardens, while tissue culture, seed, or gene banks, or microbial collections are examples of suspended *ex situ* conservation.

Ex situ and *in situ* conservation methods are complementary approaches. *Ex situ* approaches are limited in that they remove organisms or genes from their environment and from natural evolutionary pressures, whereas *in situ* approaches continue to expose organisms to natural surroundings and influences. Therefore *ex situ* approaches are best suited to cases where the *in situ* conservation of a species is difficult or impossible.

These *in situ* and *ex situ* conservation tactics stand a greater chance of success if they are integrated within a social, political, economic and institutional context. The tactics addressing the threats to biodiversity should therefore 'integrate as far as possible and appropriate, the conservation and sustainable use of biodiversity into relevant sectoral or cross-sectoral plans, programmes and policies', as called for by the Convention on Biological Diversity (CBD, Article 6).

Both the Draft Environmental Management Bill (1998) and the Biological Diversity Policy (White paper, 1997) address this integration. As discussed earlier, South Africa has formulated a national biodiversity policy identifying strategic needs for the conservation of biodiversity. In addition, the Draft Environmental Management Bill is a framework containing the goals and objectives of the government, and the powers and responsibilities of government agencies and state organs, with respect to achieving environmentally sustainable development, which is a facet of conservation of biodiversity.

2.6 Selection of the potential Gariep TFCA

The proposal to protect the Gariep TFCA is an *in situ* approach which specifically targets the Nama-karoo biome for conservation action. Focusing on the biome as a target for conservation will automatically include the genetic, species, and ecosystem levels of the biodiversity hierarchy.

The origin of the plan to conserve the Nama-karoo biome is to be found in international and national conservation planning (see section 2.3). At these levels, the development of a network of protected areas representative of all biomes, ecosystems and habitats has been identified as a conservation priority. Protection of 10% of each habitat and ecosystem type is generally considered as an indication of representativeness (see section 2.3.2).

Although South Africa has 6% of its terrestrial area formally conserved, only two of the seven biomes are conserved at 10% of their total area (Low and Rebelo, 1996). Only 2,82% the Nama-karoo biome is conserved, despite its covering almost one quarter of South Africa's land area (see chapter 1.3). The Nama-karoo biome can be further divided into six vegetation types (Low and Rebelo, 1996) of which two occur in the Gariep TFCA: the Bushmanland Nama-karoo and the Orange River Nama-karoo. The Bushmanland Nama-karoo is widespread, covering 6,5% of South Africa, yet only 0,03% of the Bushmanland Nama-karoo is protected. The Orange River Nama-karoo is less widespread, covering 4,24% of South Africa, and is slightly better conserved at 1,47% of its total area. It is evident from the above that the level of protection for both vegetation types is far below the 10% policy goal.

2.7 CRITERIA FOR EVALUATING CONSERVATION VALUE

It will often be impossible to conserve everything within a priority area, partly because land is required for uses other than conservation. Choices will therefore need to be made between various elements of biodiversity within the larger areas which have been identified by conservation policies. An evaluation of the biodiversity elements within the areas for their relative importance will assist in making rational choices. The choices will have important consequences for future biodiversity, since that which remains unprotected will be put to use in ways which may severely diminish biodiversity.

Any deliberate priority-setting uses various criteria to reduce the number of biodiversity elements that are considered for priority status. The criteria which form the basis for assessing the relative conservation values of one or several competing sites will determine the actual choices which are made, and hence the ultimate targets of conservation.

For example, the South Africa section of the Gariep TFCA has been identified as a conservation priority at the national level in recognition of its potential as a representative addition to the reserve network. The application of suitable evaluation criteria will allow specific conservation priorities to be defined *within* the Gariep TFCA.

Many different criteria for establishing the conservation values of elements of biodiversity have been developed over the decades. Margules and Usher (1981) compiled a list of 18 criteria which had been used in 9 studies assessing conservation potential (Table 2.1). Five of the criteria were common

Table 2.1: Conservation evaluation criteria, and the number of times each was used in nine studies investigated

EVALUATION CRITERIA USED	NUMBER OF STUDIES
Diversity (includes species diversity and habitat diversity)	8
Rarity	7
Naturalness	7
Area	6
Threat of human interference	6
Typicalness or representativeness	4
Educational value	3
Amenity value	3
Recorded history	3
Scientific value	2
Uniqueness	2
Wildlife reservoir potential	1
Ecological fragility	1
Position in ecological/geographic unit	1
Potential value	1
Availability	1
Replaceability	1
Management considerations	1

Source: Margules and Usher, 1981

to at least 6 of the studies, indicating the fundamental importance of these criteria for establishing conservation value. The complexity of biodiversity and the number of ways of valuing it make a host of criteria theoretically possible, but the few described here are still the most commonly used (Johnson, 1995).

In order to further define the criteria, Margules and Usher (1981) went on to classify these criteria into two broad groups (Table 2.2). The first group includes criteria of an essentially socio-political nature. Within this group are criteria such as the availability of land, threat posed by human interference, and amenity value of the area, criteria not based on scientific, ecological or biogeographic factors. Nevertheless they may play a pivotal role in the final decisions about the site which are made by government or other officials.

The second group includes criteria of a scientific nature (Table 2.2). The scientific criteria can be estimated during a site visit, as well as from survey data from the area and from the surrounding biogeographic region.

Table 2.2: Classification of conservation evaluation criteria

CATEGORIES	CRITERIA
1. Socio-Political group	Threat of human interference
	Availability
	Amenity value
	Educational value
2. Scientific group	Diversity
	Area
	Rarity
	Naturalness
	Representativeness
	Recorded history
	Potential value
	Ecological fragility

Source: Margules and Usher, 1981

A number of the criteria will be used in the conservation evaluation. Criteria particularly pertinent to this dissertation were selected and will be discussed further below. The criteria will not be discussed in terms of genetic biodiversity since the technical nature of biodiversity at the genetic level is beyond the scope of this dissertation.

1. Diversity

The criterion of diversity was the most widely used of the criteria recognised by Margules and Usher (see Table 2.1). Diversity can be measured at all levels of the biodiversity hierarchy, from genetic to ecosystem level (see Figure 2.1).

Species diversity can mean the number of different species, or a composite measure of species richness and abundance. A measure of the number of ecological interconnections *between* species has also been used to indicate species diversity (Goodman, 1975).

Species are discrete entities, and in most cases the distinction between even closely related species is well established and universally agreed upon. A count of species is a measure which will be agreed upon by most surveyors. There is relatively little detailed information available about species diversity in the Gariep TFCA. When the opportunity arises to protect an area about which detailed species information does not exist, and evaluators are not able to do detailed species surveys prior to assigning conservation value, a quick field survey can provide generalised information on ecosystem or habitat diversity.

The definition of an ecosystem or habitat is less precise and the dividing lines between ecosystems or habitats are less distinct. One person's assessment of ecosystem or habitat diversity may not agree with another's assessment in the same area. None the less, when there is a paucity of detailed species knowledge, ecosystem and habitat diversity can be used as a surrogate for species diversity. For example, Diamond (1986) made use of diversity of habitats as a criterion in designing a network of reserves in Indonesian New Guinea. Since the distribution of most vertebrates and invertebrates depends on the habitat created by plants, protecting the diversity of habitats will protect the plants and other organisms which need the habitat to support themselves in a self-sustaining population.

2. Rarity

Protection of rare or endangered species or communities has been an important function of conservation as well as a rallying point for conservation activism. Rare species are at greater risk of succumbing to extinction through human-induced effects on their habitat, because small populations are more vulnerable to catastrophes such as chance variations in birth or death rates or chance environmental changes (Terborgh and Winter, 1980).

Rarity varies with landscape scale. For example, some species are locally rare yet widely distributed whereas others are locally common but occur nowhere else. Seven forms of rarity have been described for plants, based on geographic range, habitat specificity, and local population size (see Table 2.3). These traits are really continuous, but for classification of rarity they can be treated as having discrete divisions. Of the eight combinations, only one classifies species which are considered to be common: that of a widespread species with broad habitat specificity and large local populations in at least some of its range.

Table 2.3: Seven forms of plant rarity, based on three traits

1. Geographic range (distribution)	Wide		Narrow	
2. Habitat specificity (specialization)	Broad	Restricted	Broad	Restricted
3. Local population size (abundance)	Large population somewhere in the range of the plant			
	Small population everywhere in the range of the plant			

Source: Rabinowitz, Cairns and Dillion, 1986.

Rarity, like diversity, can be applied to genes, species, or ecosystems. A site survey and some knowledge of the surrounding biogeographic regions will be required before this criterion can be adequately assessed. For example, although 4 Whitebacked Night Herons were observed along a 50 km stretch of the Orange River during the site visit in 1998 (Feasibility Study, 1998), the Atlas of Southern African Birds (Harrison *et al.*, 1997) does not have a record of this species occurring in the Gariep area. Therefore the combination of a site visit, and information about the birds of the surrounding biogeographic region, makes it possible to evaluate bird rarity in the Gariep area.

Ecosystems or habitat rarity can serve as a surrogate for detailed species information. While ecosystems or habitats are ill-defined elements of biodiversity without fixed boundaries which can be empirically determined, they are none the less functional components of the natural environment. An ecosystem-rarity approach is a realistic option in the case of the Gariep TFCA, where little is known about species distributions.

An ecosystem approach is also useful to identify sites that a species-based approach to rarity might not consider (Miller *et al.*, 1995). For example, assessment of plant species rarity in the Gariep TFCA would argue that most, if not all, of the species of plants in the riparian zone are widely distributed in South Africa, not endangered, and adequately protected in existing conservation areas all over the country. Thus the riparian vegetation species should not be valued particularly highly on the basis of the rarity criterion.

However, the riparian plant species exist as part of an interlinked system, which can be classified as a riparian ecosystem. It is strongly associated with the banks of the Orange River, and occurs in a zone of perhaps 30 m in width (see Feasibility Study, 1998). The Orange River is the only source of perennial water in the arid Gariep TFCA. Within the Gariep TFCA, this riparian ecosystem is thus exceedingly limited in area, and rare in comparison to the other ecosystems of a similar scale, none of which are associated with a perennial water source.

In addition, riparian ecosystems, especially in arid areas, may be one of the better examples of 'keystone' landscape elements, because their influence is out of all proportion to their size (Mooney *et al.*, 1995). In such cases, human interference at a small scale may have dramatic effects at landscape scale. In the event that a plant species approach does not place a high value on such a keystone ecosystem, (as is the case in the Gariep TFCA), and in the absence of any other species information, such as bird or mammal species inventories, with which the area can be evaluated, the keystone ecosystem is likely to be placed low on the conservation value hierarchy. In such a case, an ecosystem approach may be a preferable criterion for assessing the true biological value of the ecosystem.

3. Uniqueness

Uniqueness is a form of rarity, and could be included with that criterion (Margules and Usher, 1981). Assessment of uniqueness can be carried out for genetic, species, or ecosystem levels of biodiversity, and requires a survey of the site. Uniqueness is often used with reference to the occurrence of endemic species, even though the endemic may not be rare within its geographically limited range (see Table 2.3).

For example, the Gariep TFCA falls within a centre of endemism for the Mesembryanthema plants, specifically the *Titanopsis* group (Hartman, 1994; Feasibility Study, 1998), and thus application of the uniqueness criterion would value the area highly on this basis.

4. Naturalness

This criterion is often used in the sense of an absence of human influence. Human influence has, however, extended to almost every corner of the Earth for many thousands of years. Therefore the criterion is more accurately defined as the absence of artificial human disruption, or a minimum level of human disturbance (Margules and Usher, 1981).

Laut *et al.* (1978) classified the 'naturalness' of vegetation in South Australia into 4 broad categories: 'undisturbed natural' showed no alteration; 'disturbed natural' has been used for grazing or other purposes without causing marked structural and floristic changes; 'degraded natural' had suffered structural alteration but most species were still of natural origin, as for example in severely overgrazed and eroding lands; and 'cultural' consisted of areas of introduced species, often with the addition of fertilizer, water, herbicides, etc., and the original structure of the soil and flora was gone.

Within the Gariep TFCA, where the majority of the land has been used for intensive stock grazing for many decades, and for less intensive nomadic grazing for many hundreds of years before that (Feasibility Study, 1998), the vegetation can in general be classed as 'disturbed' or 'undisturbed' natural vegetation. The areas of irrigated crops and granite mining can be classified as 'cultural' (see Feasibility Study, 1998). The areas of riparian vegetation which have been invaded by alien plant species may likewise be classified as 'cultural'.

5. Threat of human interference

It is characteristic that conservation measures are often proposed as a response to threats from other land uses. The criterion was used in 6 of the 9 conservation studies (see Table 2.1). Its widespread use reflects the urgency felt by conservationists in the face of increasing competition from other land uses for a dwindling supply of available land (Margules and Usher, 1981).

The 'threat' criterion is not based on ecological principles, although the threatened biodiversity is often a rare or endangered species or habitat. Since some biodiversity elements are less likely to persist under prevailing or prospective land uses than other elements, the vulnerable elements must be given priority for protection (Pressey, 1994).

Within the Gariep TFCA, the threats to the biodiversity are posed by land uses which are more economically attractive than the predominant stock farming activities (see Feasibility Study, 1998). The magnitude of the threat is a function of the potential economic returns to be had from the land use, with higher returns increasing the chance of a change to the land use. The threat is also a function of the environmental impact commonly associated with a given land use, where a land use with minor reversible impacts is less of a threat than a land use with significant or irreversible negative impacts (see Feasibility Study, 1998).

6. Representativeness / typicalness

A whole range of species is required for an area to be representative or typical. Representation of the range of biota present on Earth is a fundamental goal of biodiversity conservation (see section 2.3), and selection of representative areas can be based on explicit criteria that define, for example, biogeographic phytochoria (a distribution of biodiversity based on plant diversity). Conservation of representative sites will not necessarily protect rare species or habitats, though. Therefore the two criteria, representativeness and rarity, should be used together to ensure maximum biodiversity is conserved.

The Gariep area was originally selected for conservation based on the criterion of representativeness – in this case, representative of the Nama-karoo biome (see section 2.6).

7. Availability, as indicated by social cost of conservation

This is not a scientific criterion and ought to have no influence on biodiversity conservation assessments or decisions. But in reality it is often a guiding criterion that helps to identify areas where conservation actions are most likely to succeed (Johnson, 1995) (see section 1.3).

The social cost associated with replacement of a land use with conservation and tourism is one measure of the extent to which conservation will be regarded as an acceptable alternative to the present land uses. The social cost is related to the socio-economic value of the land use. Thus a land use that employs few people and is economically marginal will more readily be replaceable with conservation, at a lower social cost than a land use that employs many people and is financially attractive.

A low social cost could be a factor that enhances land availability. Conversely, a high social cost could act as a barrier to availability, for example by substantially increasing the purchase price.

8. Amenity value

Amenity value is a broad criterion that can include a variety of more specific criteria. Three criteria have been selected to evaluate the usefulness of the Gariep area for tourism.

Scenic distinctiveness

The attraction of an area for tourism depends on many qualitative factors, including the scenery. In general, the more distinctive scenery will be a greater attraction.

Proximity to water

In an arid region such as the Gariep TFCA water is a strong focal point for tourist activities and accommodation.

Presence of sites of cultural and historical interest

Cultural or historical sites enhance the amenity value of an area by acting as a focus for tourist activities.

2.7 Conclusion

For the purposes of this integrated approach to establishing conservation priorities for the Gariep area (see section 2.4), the overlay evaluation will use criteria that assess biological conservation value as well as the conservation value of socio-economic and tourism features in the area. The following criteria will be used in evaluating the Gariep area:

- Rarity of ecosystems;
- Naturalness of the vegetation;
- Threat of human interference;
- Social cost of conservation;
- Scenic distinctiveness;
- Sites of cultural and historical interest; and
- Proximity to permanent water.

These criteria will be discussed further in chapter 4, which deals with the overlay evaluation of the Gariep area.

The following chapter is a description of the overlay procedure to be used in the overlay evaluation of the Gariep area.

THE OVERLAY PROCEDURE

3. THE OVERLAY PROCEDURE

3.1 BACKGROUND TO THE OVERLAY PROCEDURE

Environmental assessment is now a widely accepted and well-established part of development planning throughout the world. By the early 1990s, more than 40 countries had environmental impact assessment (EIA) programs in place for predicting and responding to the effects of developments. The EIA procedure originated in the United States with the National Environmental Protection Act of 1969 requiring federal agencies to consider the environmental impacts of their decisions.

In South Africa, environmental evaluation became a legal requirement in terms of the Environmental Conservation Act 73 of 1989, and the regulations (Government Notice No. R. 1182 and 1183, 1997) identifying activities which may not take place before the requisite EIA report has been considered and permission granted.

Environmental evaluation is about to become part of strategic development planning within South Africa with the development of the environmental management framework (EMF) by the Department of Environmental Affairs and Tourism (DEAT, 1998). The EMF is based on a series of maps depicting the environmental sensitivity of the land, and is a product of the overlay approach to land use planning. The EMF is intended as a pro-active guide for development planning as it will allow the identification of areas of potential conflict between sensitive environments and development proposals (DEAT, 1998).

The overlay mapping method, a contemporary modification of which the EMF is a product, was first described in 1969 in a seminal work, 'Design with Nature' (McHarg, 1969). The method was a formalisation of established techniques which used superimposed maps in order to highlight the coincidence of different geographical features displayed on the separate maps. McHarg introduced his 'design with nature' method as a tool for planning highway routes such that the routes would fit with the engineering and other technical requirements of highway construction *and* with the natural environment and social requirements (McHarg, 1969).

The overlay method is a means of including environmental factors into land use planning. There are two levels of land use planning for which the overlay method is suitable:

1. **Land capability planning.** This is a strategic approach, similar to the EMF approach (DEAT,1998), and is intended to divide up a given area so that the most suitable area is matched to its most suitable land use, ie. land uses are allocated to those land zones most suited for the use in question.

2. **Land suitability planning.** Land suitability planning is a project-level approach intended to find the optimal location for an intended development, such as, for example, the route to be followed by a new power line (Eastern Ontario Transmission Line Study).

The overlay method is useful where the dominant concern is to identify a suitable site for a particular point, linear (Eastern Ontario Transmission Line Study), or area-based feature or land use (Hill Kaplan Scott and Partners, 1971; DEAT, 1998). Modification and expansion of the method has been made possible by the progressive development of computer-based geographical information systems (GIS). The advent of GIS technology has facilitated intensive data manipulation and the analysis of a great number of variables in a short time. GIS technology has also facilitated the generation of overlays from complex data calculations (Bedward *et al.*, 1992).

Conservation has been described as essentially a zoning or land use planning exercise (Caldecott, 1996). A modification of the overlay method, Gap analysis, illustrates the use of overlay land use planning in the field of conservation (Scott *et al.*, 1992). The method uses GIS technology to compare the distribution of species and vegetation types with the distribution of different land management and ownership classifications, so that gaps in the protective network of reserves can be identified. The gaps so identified make it possible for conservation planning to focus on filling the gaps with new reserve acquisitions. Similar Gap analysis has been carried out for specific bird species in Hawaii (Scott *et al.*, 1986), for natural vegetation in the USA (Crumpacker *et al.*, 1988), and for general reserve planning in Australia (Specht, 1975).

This dissertation is an additional modification of the overlay approach to conservation planning, called the COVER analysis.

3.2 Overlay Procedure

In recognition of the often confusing nature of the terminology which will be used to describe the overlay method, a simple analogy may help to clarify the difference between a 'factor', a 'criterion', and a 'ranking'. A factor can be considered as the object which is to be measured, a criterion as the unit of measurement which has been chosen, and the ranking as the scale of measurement. For example: one can measure height (factor), by using meters above sea level as the unit of measurement (criterion), and then describe the height on a scale of 100-meter increments (rankings). The effect of selecting inappropriate criteria is also evident from this analogy. For example, the measurement of height (factor), by using degrees centigrade as the unit of measurement (inappropriate criterion), will result in meaningless rankings.

The process of overlay mapping is comprised of 4 steps, which are summarised in Figure 3.1, and discussed in more detail below.

Step 1: Selection of the controlling environmental factors

The accuracy and usefulness of the overlay approach is dependent on the initial selection of factors to be used for determining land use suitability. Since the method is less cumbersome if fewer factors are used, the initial list should be pared down to approximately 10 or 12 of the factors most relevant to the decisions-making.

The method is sensitive to the choice of controlling factors. The selection of the controlling factors is necessarily subjective, as will be discussed below, and a Delphi-type approach to the final selection is generally recommended (Fuggle, 1992). This will help to ensure that the factors are equally representative of the environment from a multi-faceted point of view.

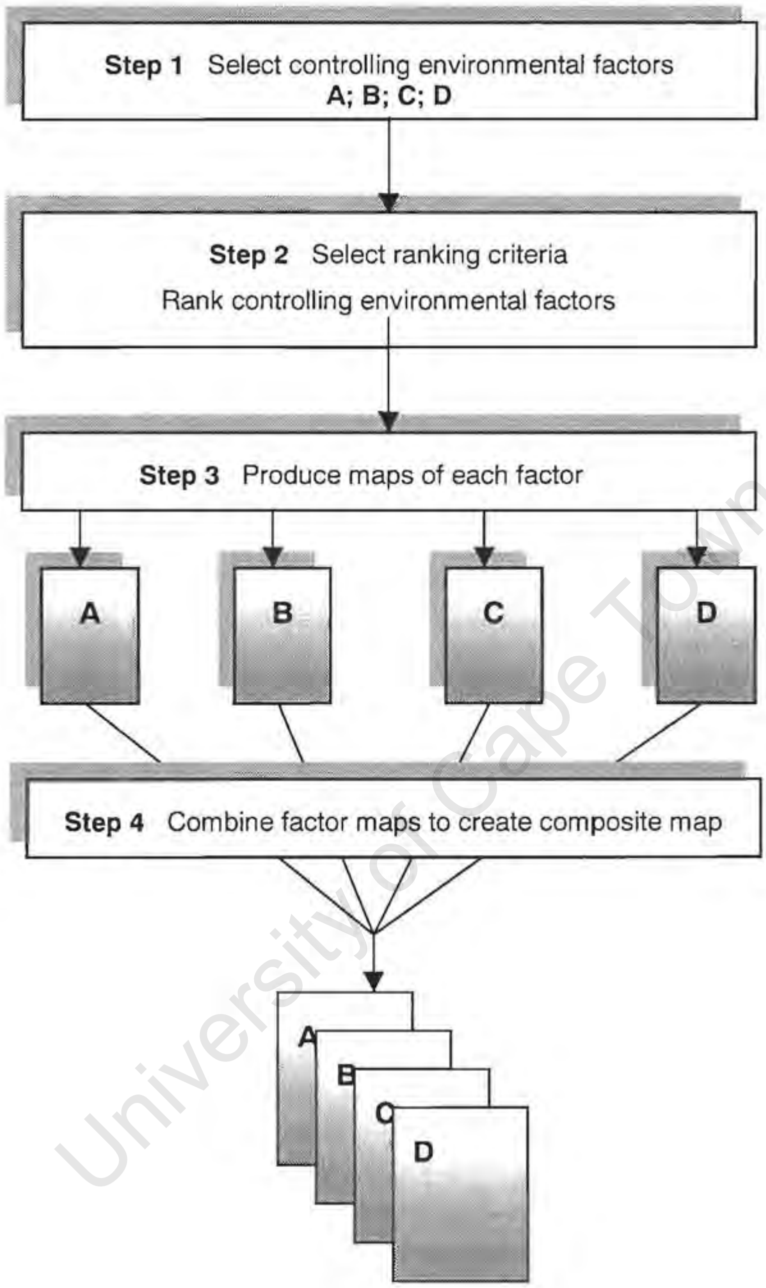


Figure 3.1: The overlay procedure

It is essential that these factors do not overemphasise the importance of one land use.

The factors which control the suitability of land for a particular use will be determined by the characteristics of the area that is being evaluated, and by the possible land use options being investigated. For example, within the Gariep area, geological makeup is a particularly important controlling factor for granite mining, because granite outcrops are potential mines, while alluvial fans will not have exploitable granite outcrops. Geology thus dictates areas of mining suitability.

In contrast, water availability is a controlling factor for grape farming, because a large amount of water is required each day to produce a healthy crop of grapes, and geology is another controlling factor, because granite outcrops are totally unsuitable for growing grapevines whereas alluvial fans are ideal for growing grapevines.

An evaluation of the Gariep area for stock farming and grape farming would need to select at least the controlling environmental factors of geology and water availability before the land can be zoned for its suitability for these land uses.

Step 2: Determine the criteria which will be used to rank the individual phenomena within each factor, and rank the phenomena by application of the criteria

Once the controlling factors have been selected, they must be evaluated for suitability for the proposed land uses. Because, as Weiner (Wallace *et al.*, 1971) points out, the environment is a series of *to whom it may concern* messages there is a need to determine what the "messages" may be. The messages are elicited by the criteria with which the controlling factors are evaluated.

Therefore for the purpose of granite mining, the geology is one of many possible controlling factors. Consequently, ranking within this factor through the use of a criterion of rock type will identify the phenomenon of granite outcrops as a higher rank, or more suitable for granite mining, than alluvial fans. The same factor and criterion, applied from a grape farmer's perspective, will identify alluvial fan and not granite outcrop areas as more suitable for grapevines.

Of particular significance to this dissertation are the messages which interest conservationists, and more specifically the SANP whose function it is to evaluate potential conservation areas. Thus the criteria which are of particular importance when decisions concerning conservation of land are made provide a measure of the conservation suitability of the land. The criteria chosen for this study were introduced in chapter 2, and will be discussed further in chapter 4.

Step 3: Produce factor maps which show the zones of differing rank

Once each controlling factor has been ranked for suitability for the proposed land uses, the spatial extent of each rank is transferred to a map. For example, ranking of the geology phenomena, from a higher rank for granite outcrops to a low rank for alluvial fans, will produce a hierarchy reflecting the differing levels of suitability for granite mining. Transferring these to a map of the area will therefore provide a spatial representation of the suitability of areas for granite mining. If these suitability zones are shaded accordingly - with the darkest shade representing the most suitable areas and the lightest shade representing the least suitable areas - the map will be able to convey the location and extent of the zones most suited for granite mining,

Step 4: Combine the factor maps into a composite suitability map

The composite map superimposes all the factor maps, each with its hierarchy of factor rankings (or suitability zones). It presents the summation of the suitability zones - the darker tones representing higher suitability and the lighter tones representing lower suitability.

There are two routes to creating the composite maps. Firstly, the simple additive overlay adds the suitability overlays one on another and the final map is interpreted only on the basis of the summed suitability zones. The additive overlay assumes that all the factors are of equal importance in influencing the final outcome of the analysis, and that they can be added together.

In reality, some factors will be more important than others in the suitability determination. In order to take account of the unequal importance of the different factors, a modification known as the filtered overlay was developed (Beaumont *et al.*, 1975).

The filtered overlay method carries the ranking of each factor through to the composite map as individual rankings without adding them, and the zones of suitability are labelled with the combination of individual rankings achieved, (rather than with the sum of the individual rankings as the additive method does). Thus, 5 factors each ranked from A to D (where A is most suitable, B is suitable, C is unsuitable, and D is most unsuitable) will result in suitability zones labelled with 5 letters, eg. AABAC, one for each factor that comprises the composite map. The ranking achieved by any zone for each factor can thus be see at a glance. This overcomes the problem faced when using the additive overlay method, namely that it is not possible to determine which factor is responsible for the maximum unsuitability.

The composite filtered overlay map is shaded for the first time, to reflect the most unsuitable ranking in the combination. Thus a zone ranked AABAC would be shaded 'unsuitable' to reflect the worst ranking in the combination, C. The filtered overlay map thus contains both a visual representation of suitabilities (as does the additive method), and a summary of the factor rankings achieved within each suitability zone (which the additive method does not do).

3.3 Strengths and Weaknesses of the Overlay Method

Overlay evaluation requires two things - a database, and an evaluation.

Selection of factors will be limited by the data which is readily available (see chapter 1.6). Shortcomings in a data base can be improved by a site visit for data collection with the specific aim of using the data in the overlay evaluation. Alternatively, further field visits can take place to provide additional data for the factors once they have been selected.

The validity of the overlay approach is dependent on the factors which are selected for the evaluation. The recommended selection method is a Delphi-type panel evaluation (Fuggle, 1992) in which a panel of people, from a variety of backgrounds relevant to the purpose of the evaluation, select the most important factors by consensus. This can minimise the subjectivity of the selection (see chapter 1.6).

A weakness of the overlay method is its inability to deal with environmental factors that can not be measured by spatial extent. For example, one can show the socio-economic value associated with a land use, but not the sphere within which the socio-economic value is experienced.

The selection of criteria is the first stage of the evaluation (Fuggle, 1992). The outcome of the overlay evaluation is affected by the criteria selected for the evaluation. The criteria can be thought of as the unit of measurement which is selected for measuring the factor. Care must be taken to ensure that the criteria are real measures of the factors which they evaluate. Incorrect criteria will result in invalid rankings and maps.

The ranking of the factors is the second stage of the evaluation (Fuggle, 1992). The number of ranking categories will influence the sensitivity of the evaluation, since a greater number of rankings allows more value distinctions to be made between the phenomena comprising each controlling factor. The outcome of an increased number of rankings will be a more detailed value map and more possible combinations between the factors making up the composite maps.

One difficulty of converting natural features into discrete elements or phenomena is that division into separate phenomena for ranking purposes unavoidably generalises the nuances of nature that are quite apparent from a visual inspection. Boundaries between vegetation types along real environmental gradients are not as sharp as implied. Ecotones and other subtle gradients could be mapped by a higher-resolution analysis of the vegetation which would then form the basis of a fine-filter conservation evaluation.

A strength of the overlay evaluation is the explicit statement of criteria (McHarg, 1969) and rankings for each factor. This means that they are accessible to decision-makers for consideration alongside the overlay maps.

Furthermore, the method allows the spatial representation of the data, as a series of maps. Results obtained due to the overlay method are directly related to topographical and other map data, making the findings accessible to the majority of people in a familiar and descriptive format. In addition, much of the data can be displayed on a single map.

Overlay evaluation is unsuitable for use in cases where the location for a feature is already fixed, or if the type of feature to be constructed is unknown. For example, the overlay method will facilitate decisions on the most suitable route for transportation up a mountain, but not for deciding which mode of transport has the least associated environmental impact. This indicates the strength of overlay methods for strategic decision-making regarding the siting of a particular activity, and its weakness when it comes to evaluating project-level design options for a specific activity.

3.4 CONCLUSIONS

The overlay approach is a method of land use planning which enables numerous environmental factors to be evaluated and the results displayed on maps. The next chapter will make use of the overlay approach to evaluate the Gariep area for its conservation importance.

CONSERVATION OVERLAY APPROACH TO THE GARIEP AREA

4. CONSERVATION OVERLAY APPROACH TO THE GARIEP AREA

Chapter 3 discussed the overlay approach, describing the 4 steps of the methodology. This chapter describes the application of the overlay approach to the Gariep TFCA. The application is discussed in the same order of steps as that of chapter 3.

This study has the aim of evaluating the Gariep area for its conservation value. Conservation value will be determined in an integrated way, making use of factors in addition to those relevant to biological conservation value. The aesthetic and cultural value of an area for tourism is also recognised to be a part of conservation value: *"A national park must combine exceptional biological and physical diversity with aesthetic beauty and possible cultural importance."* (National Parks Board, 1993). South African National Parks has also recognised that it cannot ignore the political and fiscal realities that make it imperative that conservation areas should have tourism potential as well as conservation value (National Parks Board, 1993). However, the aim of conserving exceptional diversity implies that the choice of a conservation area should ideally focus on areas which have been least altered by human influence (National Parks Board, 1993).

For all these reasons, the conservation value of the Gariep TFCA will be determined by an integrated approach that acknowledges not only the purely biological value of the area, but also the more elusive and less easily measured tourism value of the area. In addition, the social and economic value of present land uses will have an influence on any proposal to replace these uses with conservation and tourism, and the socio-economic value will also be included in the conservation evaluation.

4.1 THE OVERLAY APPROACH APPLIED TO THE GARIEP TFCA

4.1.1 Step 1: Selection of factors

The environmental factors which could possibly be used for the overlay approach are limited to those described in the Feasibility Study (1998), and the reconnaisance report for SANP (Appendix 1). "Environment" is used here in its broadest sense to include physical, biological, social, economic, cultural, historical, and political components (DEAT, 1992).

The environmental factors fall within the biophysical, socio-economic and cultural-historical categories of environmental data (see Table 4.1[1]). These environmental factors are, however, of little use until they have been interpreted as values which represent both opportunities and constraints for conservation.

The environmental factors and their significance to conservation are discussed in more detail below (see Table 4.1). Some of the factors display significance in more than one way. Each environmental factor is comprised of a number of identifiable elements or phenomena, and these will be described together with each of the relevant factors.

Physical Category of Environmental Data

- Geology factor: The area consists of two major geological phenomena, one of granite and other metamorphic and ultrametamorphic outcrops of the Namaqualand Metamorphic Complex, and the other of undulating plains consisting of freely drained sandy alluvial soils

  The geology is significant in two ways: as an indicator of habitat for fauna and flora, and as an indicator of potential land uses. Geology will not be used in the COVER approach since its significance is duplicated by the topography factor.

- Topography factor: The topography is closely related to the geology of the

[1] Table 4.1 is inserted at the end of this chapter.

area, and the terrain form is either a rolling landscape of abrupt rocky outcrops with broken and varied slopes and incised drainage lines, or flat to slightly undulating plains with dendritic drainage patterns (see Map 4.1).

As is the case for geology, topography is significant as an indicator of the type of habitat for fauna and flora, and the potential for alternative land uses. In addition, topography is significant as a determinant of the scenic distinctiveness or aesthestic value of the area for tourism.

- Hydrology factor: The presence of permanent surface water in the arid landscape is limited to the Orange River and the hot spring on the farm Warmbad Noord (see Map 4.1).

  Hydrology is significant as an indicator of habitat, as well as being a determinant of aesthetic and general recreational tourism value.

Biological Category of Environmental Data

- Landscape/vegetation assembly factor: Vegetation is closely associated with the landscape type, and eight assemblies have been described for the Gariep area. This factor is significant as a direct measure of biological conservation value. It is also significant as an indicator of habitat for fauna.

- Land use impacts factor: Land uses in the area have characteristic impacts which are significant for the effect they have on diminishing the conservation value.

- Invasive vegetation factor: The occurrence of dense stands of alien or indigenous invasive species is significant as a factor that diminishes the conservation value.

- Fauna factor: Fauna has been disturbed to a great extent by decades of stock farming and associated practices. Very little data exists on the fauna in the area, apart from anecdotal reports of the occurrence of certain mammals and birds. The area can best be evaluated, therefore, by determining the potential faunal makeup of the area. This can be deduced from a classification of the habitats which are available. Since habitat is indicated by several other factors already discussed, the fauna factor will not be used in the evaluation.

Socio-Economic Category of Environmental Data

- Land use: There are three major land uses in the Gariep area, each with a characteristic economic yield and employment capacity. This is of significance to decision-making about whether or not to replace these land uses with conservation and tourism. In addition, the land uses have distinctive environmental impacts which are significant in that they may diminish the conservation value within their sphere of activity.
- Potential Land Use factor: The Gariep area has suitable sites for expansion of the mining and viticulture activities into stock farming areas. This is significant because any expansion of these activities is likely to have immediate negative consequences for the environment and thus for the conservation value in the expansion sites.

Cultural-Historical Category of Environmental Data

- There are a number of sites of cultural or historical interest in the Gariep area. They are significant as a focus for tourist activity.

Although all of the abovementioned environmental factors have some relevance to a determination of the conservation value, not all of the environmental factors are suitable for the evaluation. For example, the level of detail available about hydrology does not lend itself to evaluation from a biological conservation perspective. In addition, some of the factors share a common conservation significance, for example the factors of topography and geology. In this case, only one factor is selected for evaluation.

The environmental factors for use in the COVER approach – the controlling factors - were selected from the factors described above (see Table 4.1). These controlling factors are discussed below.

4.1.2 Step2: Selection of ranking criteria, and ranking of the phenomena within each controlling factor

Table 4.2[2] presents the controlling environmental factors, ranking criteria, and phenomena rankings which will be used to create the COVER maps.

In order to translate the controlling factors (Table 4.2, column A) into messages of use to conservation decision-makers, the factors have been ranked by applying criteria (see chapter 2.7) as described below. (Table 4.2, column B and C):

Factor 1: Topography, ranked according to the criterion of Scenic Distinctiveness, in order to determine the aesthetic value of the topography for tourism.

Topographically varied landscape, characterised by high hills, is often preferred for viewing because of the potential for long and panoramic views. Large level plains, by contrast, are scenically less distinctive and often less preferred due to their perceived monotony. Thus the hilly areas (slope of more than 8%) receive an intermediate scenic distinctiveness rating and the large plains of Bushmanland a lower ranking. In addition, the alluvial fans, which open out to the Orange River and are hemmed in on all sides by steep granite hills, have great visual appeal. The alluvial fans are ranked as the most scenically distinctive phenomenon of the topography.

Factor 2: Hydrology, ranked according to the criterion of Proximity to Permanent Water, in order to determine its recreational value for tourism.

The Orange River is presently used for canoeing, fishing, and birdwatching. Animals congregate to drink at the Orange River, which is the only source of water in the area. The river and its environs is therefore of high tourism value as a site for water activity, and animal and bird viewing which are both major attractions of a conservation area. Water is also an attractive focal point for tourist accommodation facilities.

[2] A foldout of Table 4.2 is inserted at the end of this chapter.

For these reasons, the zone within 2 km of the Orange River is the highest ranked phenomenon, while areas further than 2 km from the river are ranked lower.

Factor 3: Sites of cultural and historical activity, ranked according to the criterion of Points of Cultural and Historical Interest, in order to determine their value for tourism.

These sites are not ranked relative to one another. Instead, sites are treated as being either present or absent, and recorded as point features when present. They are therefore superimposed on the recreation value map as an overlay of point features.

Factor 4: Landscape/Vegetation Assembly, ranked according to a criterion of Rarity of Ecosystem, in order to determine its value for biological conservation.

Each vegetation assembly is evaluated as a unit. Rarity of ecosystem is evaluated relative to the Gariep area rather than to a broader regional or national vegetation classification. This is because the initial selection of the Gariep area has been based on its national conservation significance (see chapter 2.6).

Factor 5: Invasive Vegetation, ranked according to a criterion of Naturalness, in order to determine its value for biological conservation.

The extent of the invasion indicates the naturalness of the vegetation. Invasive vegetation occurs predominantly in the riparian vegetation. Areas of the riparian vegetation that are completely invaded by *Prosopis* trees, displacing all natural plants, have been ranked as 'cultural' (see chapter 2.7). The balance of the riparian vegetation is invaded to a minor extent or not at all, and is ranked as 'disturbed natural'.

SANP favours the most natural areas for conservation (see section 4), and will consider severely degraded land for conservation only if there is no undegraded alternative available (M. Knight, pers. comm.). The 'naturalness' criterion is used as a constraint filter, to remove the cultural vegetation from the conservation valuation. Cultural vegetation is therefore ranked as no value.

Factor 6. Present land use, ranked according to a criterion of Socio-economic yield, in order to determine value for conservation.

The gross income in R/hectare/annum and the number of employees per hectare, are indicative of the socio-economic yield of the land use. Since a higher social value would be attached to a higher-yielding land use, there is a high social cost associated with displacing high-yielding land uses with conservation.

Therefore conservation of the lower socio-economic value (stock farming) is interpreted as entailing a lower social cost and consequently a higher conservation value. Conservation of the higher socio-economic value (grape farming) is interpreted as entailing the highest social cost and consequently the lowest conservation value. Granite mining has an intermediate socio-economic yield and thus also an intermediate social cost of conservation and value to conservation.

While Table 4.2 ranks all factors from the conservation perspective, the social cost is carried through the the maps as social cost and not as the value of the social cost to conservation.

Factor 7: Present land use, ranked according to a criterion of Naturalness, in order to determine its value for conservation.

The naturalness of the vegetation is a function of the present land uses. The area is classified according to the environmental impacts associated with the land use practices. The area is primarily used for grazing, and the grazing land can be classified as 'disturbed natural'. The granite mines and grape farms are classified as 'cultural', and treated as constraints on the conservation value, as discussed under factor 5.

Factor 8. Potential Land Use, ranked according to a criterion of Threat from Human Activity, in order to determine its importance to conservation.

The Gariep area can be ranked into 3 phenomena reflecting the strength of the economic incentive to convert land to other environmentally damaging uses which have been proven in the area. The more economically attractive a land use is, the greater the incentive to implement the land use. In addition, the greater the level of employment associated with the land use, the greater the social and political incentives to implement the land use.

A change of land use is not on its own a threat to conservation value. The threat to the conservation value will be posed when a potential land use has negative environmental impacts. The environmental impacts of the land uses which take place in the Gariep TFCA are described in more detail in the Feasibility Study (1998).

The highest threat to conservation value is posed by grape farming, which offers excellent financial returns and has major irreversible environmental impacts. Granite mining poses an intermediate threat because it is less financially atttractive, although mining also has major irreversible impacts. Stock farming is ranked as the lowest threat, and has been the dominant land use in the Gariep TFCA for many decades.

This completes the discussion of the first two steps of the COVER approach, namely the selection of controlling environmental factors, and the selection of criteria for ranking of the phenomena within the controlling environmental factors. The result of these steps are displayed in Table 4.2.

A description of the final two steps of the COVER approach - production of maps of the controlling environmental factors, and production of composite value maps – is presented below.

4.1.3 Step 3. Production of maps of the controlling environmental factors

The controlling environmental factors, ranked by application of suitable criteria (see Step 2 above, and Table 4.2), could indicate value from a number of land use perspectives. The two use perspectives of relevence to this dissertation are conservation and tourism (see Table 4.2, column D). Of the 8 factors selected for the COVER approach, three are more important from a tourism perspective than from a conservation perspective, and will be used to determine tourism value. Tourism is a complimentary objective of conservation, and forms a facet of the integrated conservation value. The other 5 factors are of greater importance from the conservation perspective. The relative importance of the 8 factors is indicated by the tonal intensity of the square icons in Table 4.2, the darker the tone the more important the factor.

Map 4.2. Social Cost of Conservation.

This map is a single-factor map based on a socio-economic ranking of present land uses (Table 4.2, factor 6).

The map reflects the social cost of conservation replacing existing land uses. Therefore, higher value areas are those where displacement of present land use by conservation will have the higher social cost because conservation will displace a socio-economically valuable land use. Conversely, the lower value areas are those where displacement of land use will have lower social costs. The value to conservation is the inverse of the social cost (see 4.1.2: Factor 6).

On the map, red zones represent areas of higher social cost, blue zones are areas of intermediate social cost, while the green zone represents the lower social cost.

Map 4.3. Threat from human activity.

This map is a single-factor map representing the threat posed by potential land uses (Table 4.2, factor 8.).

The threats are represented in patterns of red on the map: horizontal hatched a-eas face the highest threat, dense red dots highlight areas of intermediate threat, and widely-spaced dots highlight areas facing lowest threat.

4.1.4 Step 4. Production of composite maps

The additive overlay method was used to create composite maps using some of the factor maps.

Map 4.4. Biological Conservation Value.

The map is a composite of the vegetation factor, invasive vegetation factor, and land use vegetation factor (see Table 4.2, factors 3, 4, and 7).

The biological conservation value map portrays 4 values: the darker the tone, the higher the conservation value. The red zones represent areas where land use practices (factor 7) or the occurrence of invasive plants (factor 4) has resulted in vegetation classified as 'cultural' (see section 2.7.4). Classification of vegetation as 'cultural' removed that zone from the ranking hierarchy, and these zones are judged to be of no conservation value.

Map 4.5. Tourism Value.

The map is a composite of the factors topography and hydrology (see Table 4.2, factor 1 and 2). A third factor, places of cultural and historical interest (Table 4.2, factor 5) has not been ranked, and therefore its phenomena do not influence the composite values.

The values are represented in shades of green, with darker tone signifying greater tourism value. A simple overlay has been added visually to the composite, identifying places of cultural and historical interest with purple symbols.

Map 4.6. Integrated Conservation Value.

Conservation and tourism are complementary objectives of SANP (see chapter 4) and part of an integrated approach to conservation (see chapter 2.4.4). However, they are not equally important objectives.

Biological conservation value was estimated to be three times as important as tourism value in influencing the decision-making by conservation bodies such as SANP. Accordingly, this map is a weighted linear combination of the biological conservation value (Map 4.4) and the tourism value (Map 4.5).

The darker tones represent zones of higher integrated conservation value. The red areas have no value for conservation.

Map 4.7. Threat to Integrated Conservation Value.

This map superimposes the threat to the conservation value (Map 4.3) on the integrated conservation value (Map 4.6). It serves to 'red flag' the areas which run a greater risk of being devalued due to land use changes.

The red horizontally hatched zones identify areas facing the highest threat to the present integrated conservation value. The dense red dots highlight areas facing an intermediate threat. The widely-spaced red dots identify areas where a low threat is posed by continuing stock farming.

4.2 Conclusions

This chapter has described the procedure followed in applying the overlay approach to the Gariep TFCA (see Table 4.1 and 4.2). It has also presented the results of the COVER approach by describing the maps which have been developed. These maps are a spatial presentation of the factor rankings (see Map 4.2 – 4.7). The next chapter briefly discusses the maps resulting from the COVER approach.

Table 4.1 : Environmental factors in the Gariep TFCA, and their significance for conservation

CATEGORY OF ENVIRONMENTAL DATA	ENVIRONMENTAL FACTORS	SIGNIFICANCE OF THE FACTORS
PHYSICAL	Geology	Habitat indicator Land use indicator
	Topography	Habitat indicator Land use indicator Aesthetic value indicator
	Hydrology: water permanence;	Habitat indicator Aesthetic value indicator Recreational use indicator
BIOLOGICAL	Landscape/vegetation assembly	Species diversity indicator Habitat indicator
	Present Land Use impacts	Disturbance indicator
	Invasive vegetation	Disturbance indicator
	Fauna	Species diversity indicator
SOCIO-ECONOMIC	Present Land Use	Conservation potential indicator
	Potential Land Use	Threat to conservation value
CULTURAL-HISTORICAL	Sites of past activities	Tourism value indicator

Note: *The unshaded environmental factors will be used in the COVER approach*

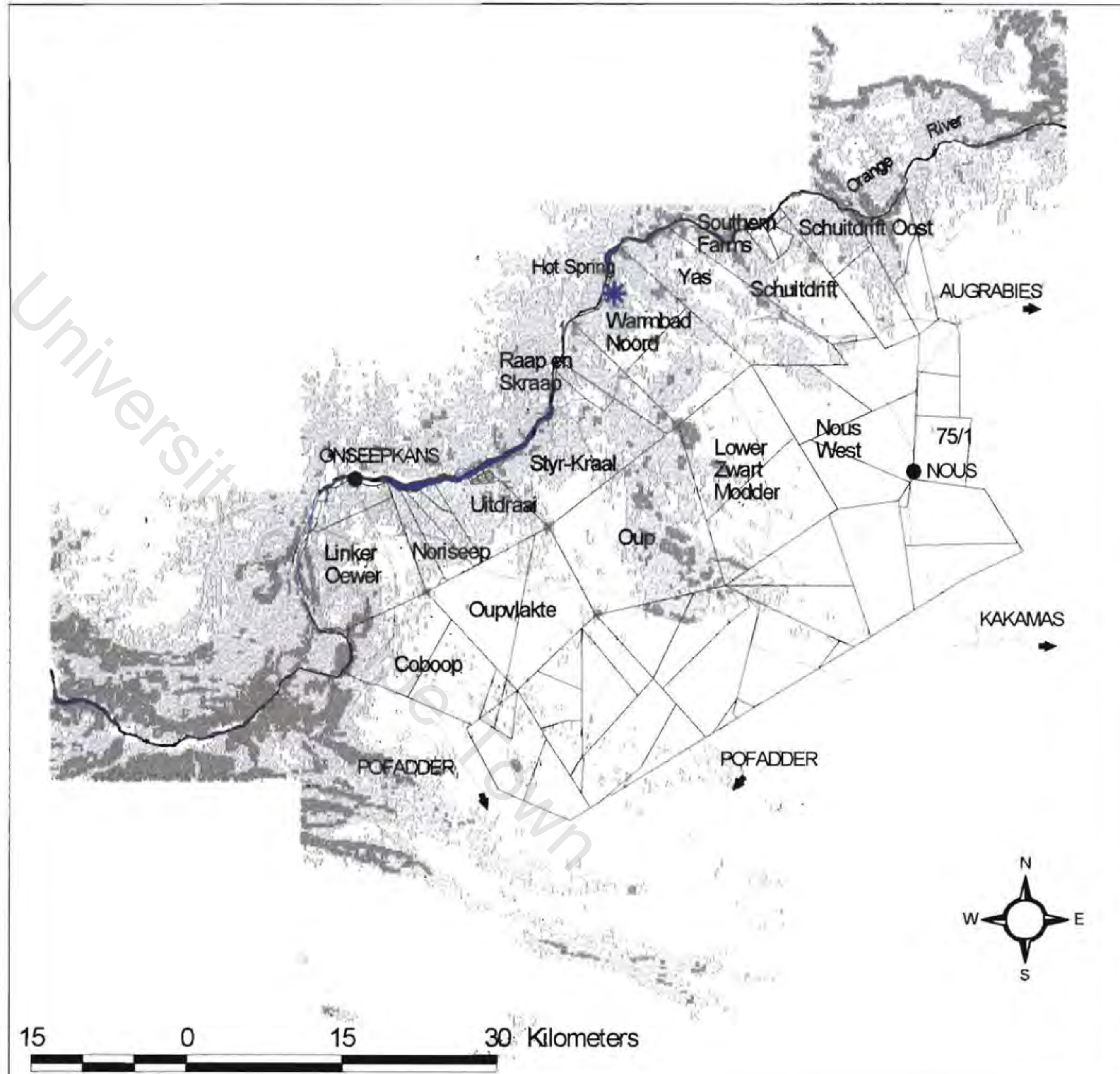
Table 4.2: Environmental factors and rankings for COVER approach

A. ONMENTAL ACTORS	B. RANKING CRITERIA	C. PHENOMENA RANKING			D. VALUE FOR LAND	
		I lower	II intermediate	III higher	Conservation	Tour
GRAPHY	Scenic distinctiveness	Gentle plains	Hilly rock outcrops	Alluvial fans		
OLOGY e River	Proximity to river	> 2 km from river		Within 2 km of river		
TATION ape/vegetation bly	Rarity of ecosystem within Gariep TFCA area	Plains vegetation	Alluvial fans shrubland; Hills vegetation	Riparian forest; Floodplains woodland; *A. dichotoma* forest; Drainage lines vegetation		
SIVE TATION	Naturalness		Degraded natural	Disturbed natural		
JRAL AND RICAL SITES	Points of cultural and historical interest					
USE t	Socio-Economic yield: employment level (person/hectare) gross income (R/hectare/annum)	>100 person/ha R120 000/ha/annum	<20 person/ha R12 000/ha/annum	<1 person/ha < R100/ha/annum		
USE impact on						

MAP 4.1

TOPOGRAPHY AND HYDROLOGY

GARIEP AREA



Styr-kraal Farm names
● ONSEEPKANS Town Names
* Hot Spring
Orange River
Orange River
Farm boundaries
Secondary roads
Topography
Plains
Hills 6-10% slope
Hills >10% slope

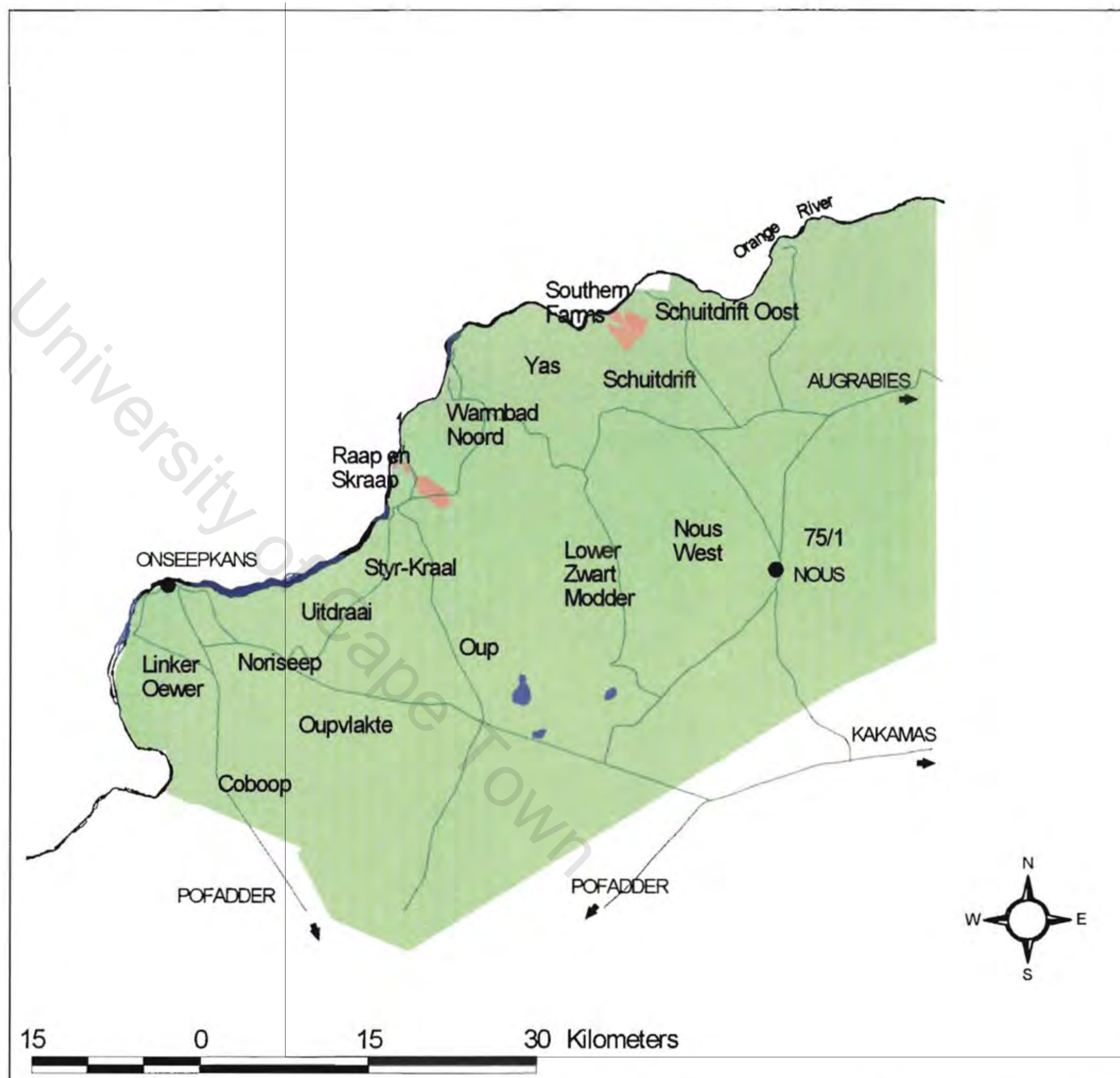
MAP 4.2

SOCIAL COST OF CONSERVATION

GARIEP AREA

● ONSEEPKANS Town Names
Styr-Kraal Farm names
Secondary roads
Orange River
Orange River

Social cost of conservation
Higher
Intermediate
Lower



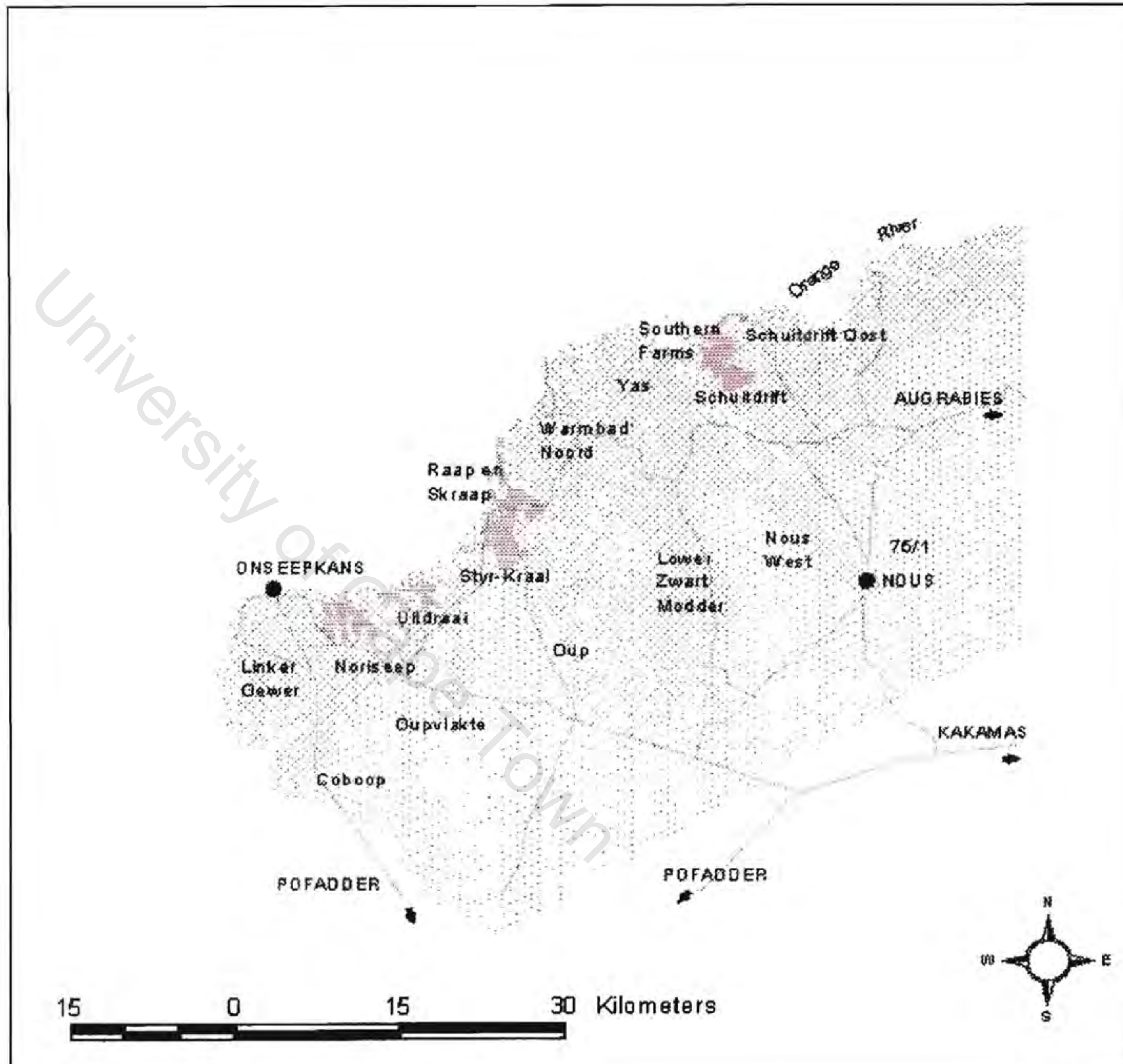
MAP 4.3

THREAT FROM HUMAN ACTIVITY

GARIEP AREA

	Secondary roads
Styr-kraal	Farm names
● ONSEEPKANS	Town names

Threat from human activity
- Lower
- Intermediate
- Higher



MAP 4.4

BIOLOGICAL CONSERVATION VALUE

GARIEP AREA

Secondary roads

● ONSEEPKANS Town Names

Styr-Kraal Farm names

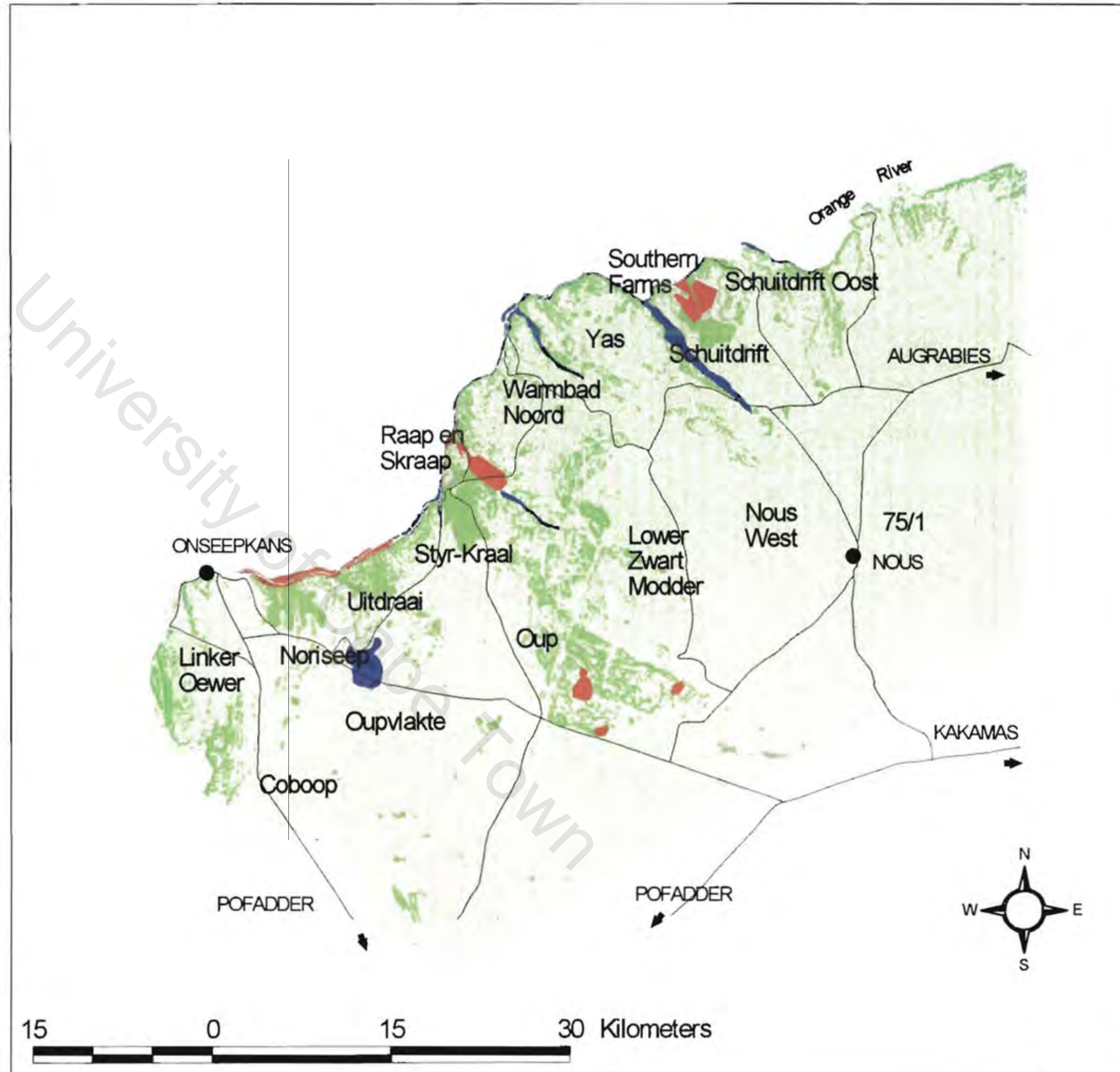
Biological conservation value

No value

Lower

Intermediate

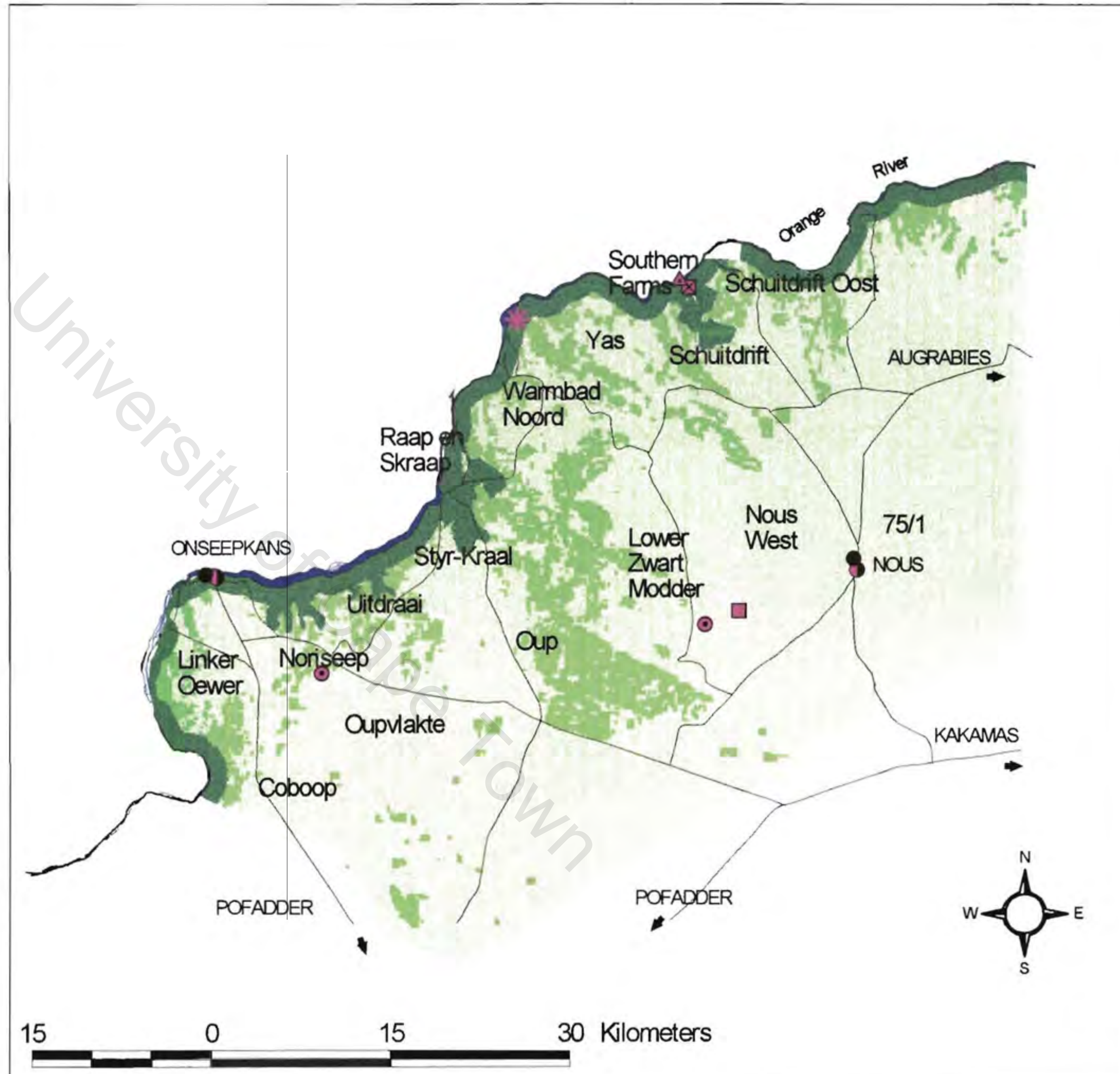
Higher



MAP 4.5

TOURISM VALUE

GARIEP AREA



Cultural and historical sites
- Aboriginal Graves
- Boer War Site
- Drift
- Hot Spring
- Mission Station
- Stone Age Settlement
- Orange River
- Orange River
- Secondary roads

● ONSEEPKANS Town Names

Styr-Kraal Farm names

Tourism value
- Lower
- Intermediate
- Higher

MAP 4.6

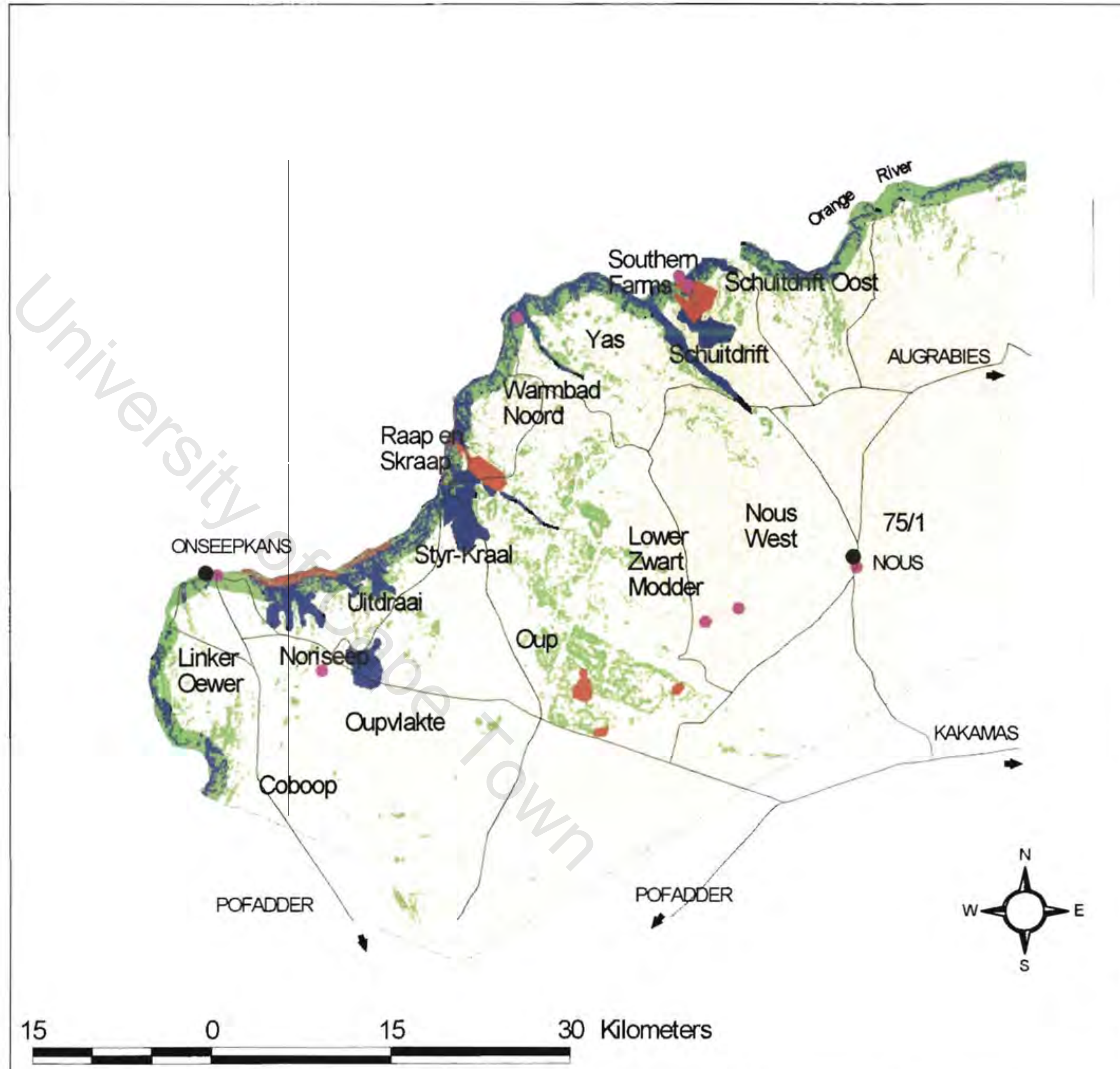
INTEGRATED CONSERVATION VALUE

GARIEP AREA

Secondary roads
Cultural and historical sites

● ONSEEPKANS Town Names
Styr-Kraal Farm names

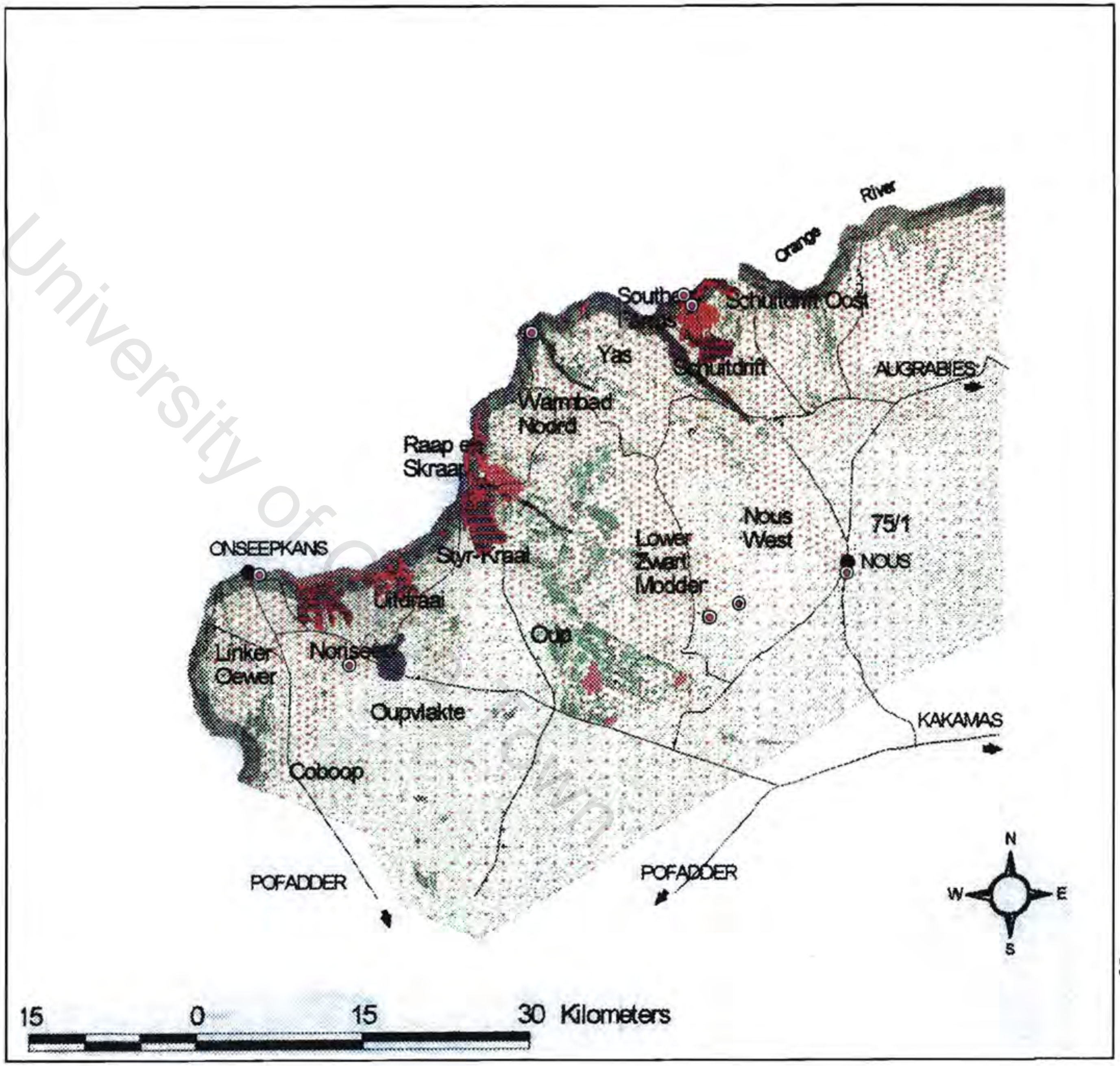
Integrated conservation and tourism value
Lower
Intermediate
Higher
No value



MAP 4.7

THREAT TO INTEGRATED CONSERVATION VALUE

GARIEP AREA



Secondary roads

Cultural and historical sites

Styr-kraal — Farm names

● ONSEEPKANS — Town names

Threat from human activity
- Lower
- Intermediate
- Higher

Integrated conservation and tourism value
- Lower
- Intermediate
- Higher
- No value

DISCUSSION OF COVER EVALUATION

5. DISCUSSION OF COVER EVALUATION

One objective of this study is to produce maps which present the evaluated environmental data of the Gariep TFCA in a simple and informative way. The maps are a product of the COVER evaluation of the Gariep TFCA, and are intended to be a decision-support instrument. Both the COVER evaluation and the maps were presented in chapter 4.

All of the evaluated environmental data is displayed on two maps, one composite displaying the threat to the integrated conservation value, the other a single factor map, the social cost of conservation.

The following chapter discusses the composite "Threat to Integrated Conservation Value" map and the "Social Cost of Conservation" map.

5.1 THE INTEGRATED CONSERVATION VALUE

Overview

The composite "Threat to Integrated Conservation Value" map (Map 4.7) shows the integrated conservation value of the Gariep area as well as the multi-level threat posed by potential land uses. The integrated conservation value is a weighted combination of the biological conservation and the tourism values (see chapter 4.1.4).

Zone of high integrated conservation value

The map highlights an irregular zone within 2 km of the Orange River – the river zone - which has the highest integrated conservation value (shaded purple). The high value is associated with the narrow strips of riparian vegetation along the Orange River, the hilly topography with associated vegetation, the alluvial fans with associated vegetation, and the three major drainage lines. The alluvial fans and drainage lines extend from the Orange

River to some distance beyond the river zone. Beyond the river zone, an isolated high value zone encompasses the *Aloe dichotoma* forest.

Zone of intermediate integrated conservation value

The zone of intermediate integrated conservation value (shaded dark green) within 2 km of the Orange River is composed of level topography which is not alluvial fan. Beyond the river zone, the intermediate value is associated with the hilly topography and associated vegetation.

Zone of low integrated conservation value

The low value is associated with the plains and associated plains vegetation.

Zone of no value

The riparian vegetation between Styr-Kraal and Onseepkans which is seriously invaded by the alien *Prosopis* plants has been allocated no conservation value, along with the grape farms Raap en Skraap and Southern Farms, and the three granite mines in the vicinity of Oup.

However, in reality it will be possible to at least partially rehabilitate the riparian vegetation. These sections of the riparian vegetation could therefore be considered for conservation, particularly if it proves difficult to conserve alternative areas of the riparian zone, or if they provide a way of linking two separate conserved areas to form one contiguous area.

Significance for decision-makers

The integrated conservation values are significant in directing the attention to zones of higher value where tourism potential and biological conservation objectives coincide. This combination of technical and non-technical information is provided in recognition of the realistic decision-making paradigm. The integrated evaluation will contribute to a conservation area which is created from the outset with multi-faceted potential benefits in mind. Amongst these benefits are biodiversity conservation and the social and economic benefits of sustainable tourism.

5.2 THE THREAT TO THE INTEGRATED CONSERVATION VALUE

Overview

The threat to the integrated conservation value is to be found in the potential suitability of the land for alternative land uses.

The Gariep area has traditionally been a stock-farming area, with some mining activity occurring on a small-scale. However, mining activity is becoming more prevalent as farmers attempt to supplement their small and irregular stock farming incomes (Feasibility Study, 1998). While the aridity and lack of infrastructure in the Gariep area severely limits the land use options, access to the Orange River and to the electricity grid has facilitated the development of farms which produce table grapes for the lucrative export market (Feasibility Study, 1998). For irrigation of the vines, grape farms need to be close to the Orange River. The alluvial fans provide a large expanse of arable land on the banks of the Orange River, ideal for grape vines.

High threat zone

The greatest threat is posed by grape farming on the alluvial fans. The alluvial fans are one of the areas of highest integrated conservation value. Conservation of the alluvial fans should therefore be the first priority, if their conversion for grape farming is to be pre-empted.

Intermediate threat zone

The intermediate threat, posed by granite mining, is restricted to the hilly topography. The high-value hills within the river zone are at risk to the same extent as the intermediate-value hills in the remainder of the Gariep area. However, because the river zone comprises both high and intermediate value features, this river zone should be a high priority to conserve in its entirity. Any mining activity within the river zone will diminish the value of the whole zone by creating pockets of environmental damage scattered throughout the hilly area.

A slightly lower priority for conservation are the hill zones of intermediate value that occur beyond the river zone.

Low threat zone

The lowest threat is posed to the level plains including the *Aloe dichotoma* forest, and the narrow riparian vegetation zone. The plains are used for stock farming, an activity that is likely to continue. It may not be necessary to prioritise conservation of the plains since, in addition to facing a low threat, their integrated conservation value is low.

Despite the fact that they face a low threat, the higher value of the *Aloe dichotoma* forest and the riparian vegetation zones referred to earlier highlights them as a higher conservation priority than the plains.

Significance to decision-makers

The levels of threat are strategic information which assist priority setting by indicating a time scale within which decision must be made, conservation priorities identified, and action taken.

As profitability of the land uses changes or as new land use options are facilitated by easier access to the electricity grid, the threat levels may change. A second iteration of this COVER evaluation should be carried out if circumstances change. However, the composite map displays seven factors, and the river zone in particular will become difficult to interpret if many more factors are included.

5.3 THE SOCIAL COST OF CONSERVATION

The social cost was retained as a single-factor, in order to ensure that the socio-economic information was not subsumed in the integrated values which are all based on the conservation perspective. The information provides a social perspective, has a significance which is different to that of information viewed from a conservation perspective, and has thus been kept apart.

Where there is competition between conservation and other land uses it is important to show that the benefits of conservation and tourism could compensate for the benefits of the other land uses.

A group of three different tourist facilities in the Gariep area could provide employment for approximately 230 people, and an estimated accommodation income of R140 000 per day at full occupancy (Feasibility Study, 1998). This is equivalent to an employment rate of 1 person/900 ha, and a gross income of R255/ha/annum. This estimated potential socio-economic return from conservation and tourism could therefore compete favourably with the returns from stock farming, but not with granite mining of grape farming (see Table 4.2).

Low social cost

The green-shaded area of the social cost map reflect the low social cost associated with conserving the stock farming areas, which are of low socio-economic value.

Intermediate social cost

In the short term conservation and tourism would be unlikely to provide benefits equivalent to those which are currently provided by a small granite mine. Therefore an intermediate social cost is associated with conservation of the granite mines.

High social cost

The highest social cost is associated with conservation of the grape farms.

Significance to decision-makers

A cost-benefit analysis (CBA) is a decision-support technique for determining whether the economic costs of a project are outweighed by the benefits it creates. A major cost of conservation in the Gariep area will be the displacement of existing land uses. One way of estimating the cost is to determine the socio-economic value of the land use. The social value map is a rough guide indicating land use zones and the relative costs of conservation within these zones.

In evaluating the social cost, an assumption has been made that conservation will totally displace other land uses. In reality, it is possible that land use management strategies can be implemented which allow conservation, tourism, and a certain amount of farming or mining to co-exist in a mutually beneficial way.

CONCLUSIONS AND RECOMMENDATIONS

6. CONCLUSIONS AND RECOMMENDATIONS

> *"We should judge every scrap of biodiversity as priceless while we learn to use it and come to understand what it means to humanity. We should not knowingly allow any species or race to go extinct....There can be no purpose more enspiriting than to begin the age of restoration, reweaving the wondrous diversity of life that still surrounds us."*

E. O. Wilson, (1992).

Conservation of biodiversity is a prudent goal for the coming decades, if we are to stem the tide which is presently impoverishing life's variety and threatening to change the Earth into a habitat which is less accommodating to the needs of all its co-existing dependants.

Of the two broad tactics of *ex situ* and *in situ* conservation, discussed in section 2, *in situ* conservation will play the dominant role into the future (Soulè; 1991). Developing *in situ* reserves depends on how well biodiversity can be measured for the purpose of conservation planning, and on how the available data are used to make decisions about the reservation (Pressey *et al.*, 1993).

Decisions about what to conserve can not be held in abeyance until biodiversity has been measured in sufficient detail for species inventories to be compiled, or ecosystem functions to be measured. Firstly, there are not enough conservation resources available for carrying out in depth surveys of all areas of potential conservation value within a short time span. Secondly, the window of conservation opportunity may be closed by other land uses in the interim before in depth surveys have been carried out (Feasibility Study, 1998).

This study is in many respects a rapid, coarse-filter assessment. The rapid assessment approach for evaluating the conservation potential and threats posed to an area was originated by Conservation International (Miller *et al.*, 1995), in parts of the world where major and rapid changes are occurring, and little data is available. Rapid assessment is necessary in cases where conservation opportunities only exists for a limited time, and neither time nor resources allow for the detailed data collecting and analysis that many other conservation evaluation methods are reliant on (Margules *et al.*, 1988; Bedward *et al.*, 1992; Rebelo, 1994). In the case of the Gariep TFCA, the information available is limited to that collected for the Feasibility Study (1998), and the preliminary reconnaisance report (Appendix 1).

6.1 Conclusions

As mentioned at the start of this dissertation, the Gariep area was identified as a potential TFCA which would protect the under-conserved Nama-karoo biome of South Africa. In order for the desire to conserve an area to be translated into the concrete form of a reserve it is necessary for the shape and size of the area to be defined in such a way that it optimally satisfies the criteria for conservation. These criteria will be broadly based on the accepted underlying aims and objectives of conservation.

There are two broad approaches to conservation planning. One is a scientific approach which concentrates on biodiversity conservation. However, although scientific considerations may be the origin of plans to conserve a new area, and providing ecologically sensible answers to questions of reserve design is a difficult enough task, an integrated approach takes cognisance of factors in addition to those which are relevant to biodiversity conservation.

The additional factors include, for example: the value of the area for tourism; the current land use practices; the number of people who depend on the land; the likely social cost of conserving the area; how much of the land is in need of urgent protection; and, how much of the area is not at risk of degradation in the immediate future and can be brought under protection at a later date.

Due to the competing needs for land, and the high cost of acquisition and management, there is a great need for the process of reservation to be socially and politically justifiable. Decisions concerning the design of a conserved area should therefore consider a wider range of factors than those of a purely scientific nature. While it may be agreed that the available scientific information supports the need for a reserve to be created, many reserves never make it beyond the planning stage, and remain 'paper parks' (Caldecott, 1996), often for want of enough information from a social and political context. One of the possible reasons for this is that planning neglects to include factors other than the ecological ones.

Land use planning is a means of finding the optimum fit between conservation requirements, the existing biological, physical and social conditions, and the potential sustainable uses, such as tourism, that a conservation area can offer. The method should be powerful enough to handle large amounts of data and flexible enough to accommodate different criteria for reserve design.

This dissertation has used the overlay method of land use planning to provide information suitable for use by decision-makers. A large amount of data has been combined and evaluated for its importance to conservation. The information is portrayed on several maps.

The overlay approach to land use planning is well suited for dealing with the coarse-filter large-scale data that can be readily ascertained from a short field visit. The method can rapidly provide the type of information needed by decision-makers, in a readily understandable format relating directly to the landscape and the land use practices.

The COVER evaluation demonstrates that it is possible to identify areas of integrated conservation value that combine ecological, social, and economic suitability. The maps are a readily understandable decision-support instrument, useful for a number of purposes:

- assist with defining priorities for conservation action;
- provide the background information for deciding on management strategies in the area;
- inform the public of the proposal to conserve the Gariep area, and provide a foundation for negotiations with land owners and other interested and affected parties.

6.2 Recommendations

The recommendations are based on Map 4.6: 'Threat to integrated conservation value'. Although recommendations relate to the value zones, the conservation priorities are defined in terms of the existing farms (Map 6.1).

Conservation priorities

The highly threatened alluvial fans should receive pre-emptive attention before the window of opportunity closes and the threats eventuate. This is all the more important when the high conservation value of these alluvial fans is taken into consideration. Farms which include alluvial fans are therefore given a highest priority. (Farms shaded blue on Map 6.1).

The second priority for conservation action should be the high/intermediate value river zone which has not been included in the first priority described above (Farms shaded red on Map 6.1). This is particularly so because the river zone is an indispensible asset for tourism, and its value will be diminished by granite mining.

A third priority (Farms shaded green on Map 6.1) for conservation is the *A. dichotoma* forest which is of high value, although not highly threatened, and one of the largest and densest of such forests. Part of the forest is included in the first priority, since it extends across the farm boundaries between Oupvlakte, Noriseep, and Uitdraai. However, the remainder, on the farm Oupvlakte, should be protected as a third priority, in order to conserve the complete ecosystem.

Conservation of the hill zones is also a third priority (Farms shaded green on Map 6.1). Given that electricity will be supplied by 2003, which may well lead to increased mining activity, measures to conserve the hill zones should be in place by then.

The hill-plain ecotones should be protected as a fourth priority (Farms shaded purple on Map 6.1). These areas where level plains give way to granite outcrops are partially threatened by granite mining. Conservation of the plains is the lowest priority, as they are not particularly threatened except by the continuing stock farming (Farms shaded pink on Map 6.1).

A reserve must ultimately be a functional entity, and it serves no purpose to conserve an area, no matter how diverse it is, if species cannot reproduce, or if it cannot be protected from biological invasions, pollution, or resource exploitation.

Because of the isolated and patchy rainfall experienced in the arid Gariep area, it is ecologically sensible to ultimately conserve one large contiguous area, as proposed by the PPF. This will be particularly important if game animals are to be reintroduced. The strategy should therefore be to gradually expand from a core area. The conservation priorities detailed above are based on core areas of alluvial fan and river zone. The area should be gradually expanded outwards and towards the south to include the less threatened elements of the Gariep area. This can be done whenever sufficient funds and conservation resources become available, as particularly the plains vegetation is not at great risk of sudden of irreversible environmental degradation.

Bearing in mind the importance attached to developing a representative reserve network, protection should eventually be extended to include all the ecosystems occurring in the Gariep area. Discussing whether this is done by purchasing the land, or by means of other contractual arrangements, is beyond the scope of this dissertation.

Management

Progress in conservation of biodiversity should not be measured simply in hectares, nor in representation of natural features. Instead it should be measured in terms of whether the most appropriate protection measures have been instituted. In designing the Gariep TFCA it will be important to decide on the location of core conservation areas, buffer zones, and corridors, and the siting of tourist facilities or other infrastructure. The location and management needs of these areas may make it unnecessary to purchase some of the land, which can possibly be conserved under contractual agreement with the owners. The COVER evaluation provides the type of spatial information which will be required when design and management decisions are made.

Public consultation

It is important that the community in the Gariep area be involved in the conservation planning as soon as possible. Although this overlay evaluation has incorporated the social cost of conservation, using socio-economic value of land use as a surrogate, this is not a replacement for social input. The planning to date has not involved any public participation, a weakness which is contrary to the mission of the PPF, and the established principles of Integrated Environmental Management (DEAT, 1992). However, the overlay evaluation can play an important role in the public consultation process. The maps provide information in a readily understandable format, providing a starting point for negotiations and assisting in identification of important issues, constraints and opportunities.

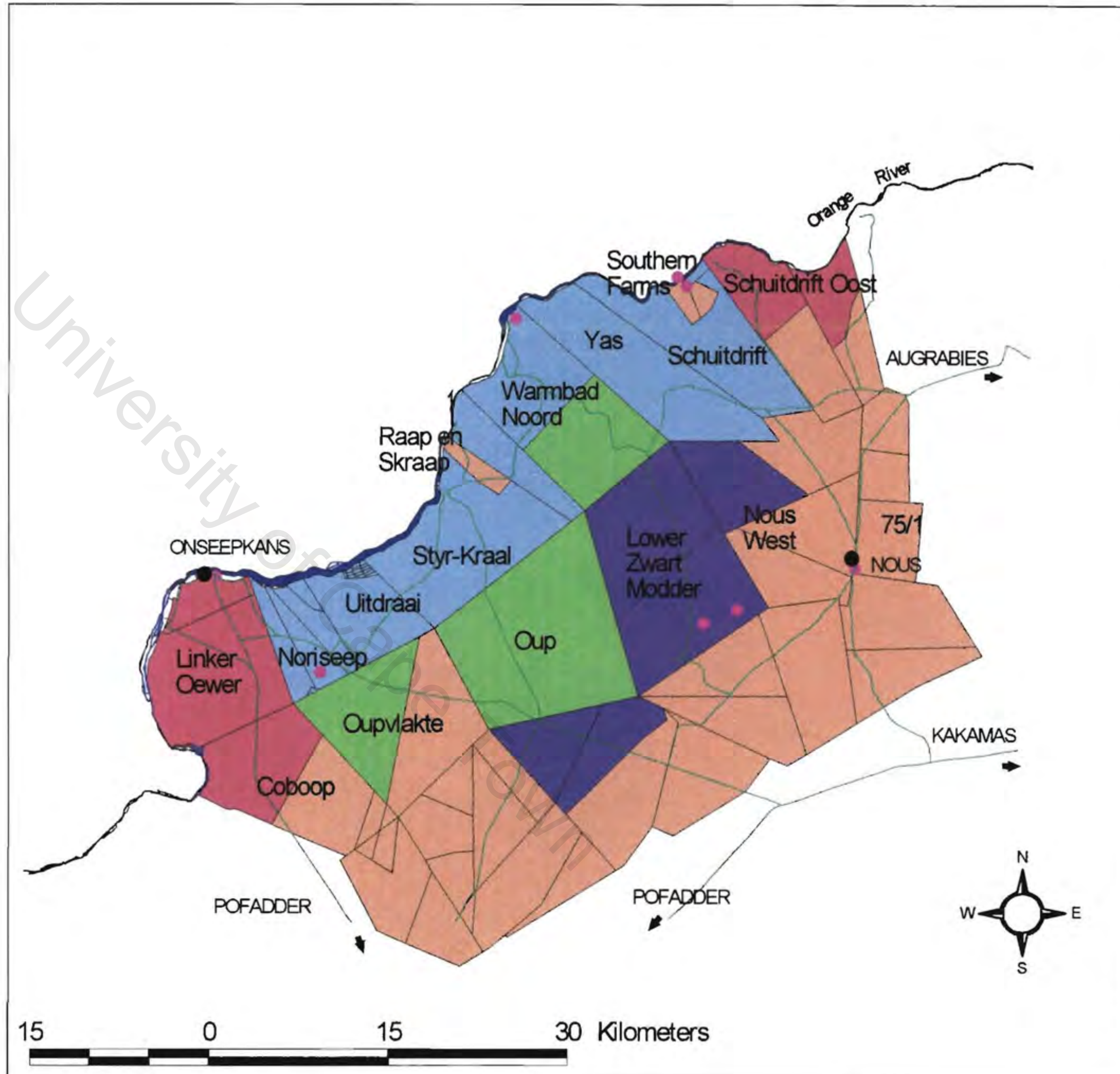
Expansion of the COVER evaluation

This COVER evaluation should not be extrapolated to areas beyond the boundaries. If decisions are to be made with respect to the Namibian section of the proposed Gariep TFCA then the incorporation and evaluation of additional environmental data from the Namibia section will be necessary. Extending the evaluated area in this way may affect the evaluation by altering the rankings given to some of the factors. However, while an extended evaluation may alter the relative conservation values, the relative threats are unlikely to change when the Namibian section is incorporated in the evaluation.

MAP 6.1

CONSERVATION PRIORITIES

GARIEP AREA



- ● ONSEEPKANS Town Names
- Styr-Kraal Farm names
- Secondary roads
- Cultural and historical sites
- Orange River
- Orange River

Conservation priorities

- Higher
- Lower

SOURCES

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APPENDIX 1

Confidential report

Report on the landscape / vegetation of the possible transfrontier National Park in the Onseepkans area.

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August 1997

Summary

A reconnaissance survey of the landscape / vegetation in the proposed transfrontier national park in the Onseepkans area was undertaken. Two areas on the South African side were identified as possibilities and the two areas were separately evaluated. Area A refers to the area between Onseepkans and Augrabies Falls National Park (AFNP) while Area B refers to the area between Onseepkans and Goodhouse. It was concluded that Area A is the better option. Reasons for this are the following:

(i) This area could be linked to the AFNP via the southern bank.
(ii) A healthy population of the *Aloe dichotoma* (Kokerboom) Woodland near Onseepkans is worth conserving.
(iii) The poorly conserved Bushmanland Nama Karoo is well represented in this area.
(iv) Except for some agricultural developments near to the Orange River, no settlements were recorded.

Introduction

The conflicting vegetation descriptions by Acocks (1988) and Hoffman (1996) of the Onseepkans area warrant further investigation before making a final conclusion regarding the vegetation.

Two possible areas for the possible transfrontier national park in the Onseepkans area were mentioned by Dr M Knight. The one area is between the Augrabies Falls National Park (AFNP) and Onseepkans (Area A) while the second area is between Pella and Goodhouse (Area B)(Figure 1).

A reconnaissance survey was undertaken to evaluated the different views of Acocks (1988) and Hoffman (1996) on the vegetation units as well as to determine the presence and the extent of the *Aloe dichotoma* Woodland.

A. Background information

Description of the vegetation and habitat

According to Acocks (1988) the Namaqualand Broken Veld Type has three variations.

1) Typical Namaqualand Broken Veld (Veld Type 33a)

The dome-shaped granite hills and the rarer quartzite hills are very prominent away from the Orange River. The country is very broken and steep. The granite "domes" encourage a surprising amount of shrubbiness by increasing the effective rainfall on the slopes below them. This habitat is charaterized by *Aloe dichotoma* and is mainly distinguished from the Orange River Broken Veld by the absence of *Euphorbia avasmontana* and by the importance of succulents, both mesembs and others (Acocks 1988). Acocks (1988) mentioned some curious and extensive "forests" of *Aloe dichotoma*, on granite gravel slopes between Pofadder and the Orange River.

2) *Rhigozum trichotomum* Veld (Veld Type 33b)

The gravelly plains in the Orange River Valley is also represented in this area. This *Rhigozum trichotomum* Veld is very similar to the variation of the Orange River Broken Veld described by Acocks (1988).

3) False Desert Grassveld (Veld Type 33c)

This variation occurs in the more open parts of the *Rhigozum tricotomum* Veld which is possibly the result of utilization of the karoo bushes (Acocks 1988).

Vegetation of South Africa, Lesotho and Swaziland (Low and Rebelo 1996).

Hoffman (1996a) described the possible transfrontier Onseepkans area as part of the Orange River Nama Karoo (Vegetation type 51) (Figure 1). According to Hoffman (1996a) the area is very rocky and possesses a "broken" topography with *Aloe dichotoma*, *Euphorbia avasmontana* and *E. gregaria* normally associated with the mountains and hills. On the pediments, *Acacia mellifera*, *Rhigozum trichotomum* and *Boscia albitrunca* are common shrubs while *Stipagrostis uniplumis* often dominates the plains.

The Bushmanland Nama Karoo (Vegetation type 49) occur~~r~~s to the south of the area according to Hoffman (1996b)(Figure 1). The topography is generally flat and is in the most arid part of South Africa. Hoffman (1996b) described this vegetation type as dominated by annuals and non-succulent shrubs. An interesting observation by Hoffman (1996b) is that this type has the highest proportion of annuals of all the Nama Karoo types. Annuals, such as *Pentzia annua* and *Zygophyllum simplex* (Brakspekbos), are common and together with geophytes comprise nearly 50 % of the total number of species in the region. The sandy parts are dominated by *Salsola tuberculata* (Cauliflower Ganna) and after good summer rains by *Stipagrostis obtusa* (Small Bushman Grass) and *S. ciliata* (Tall Bushman Grass) species. The more rocky parts are dominated by *Eriocephalus spinescens* (Thorny Kapokbush), *Eberlanzia spinescens* (Thorn Vygie) and *Rhigozum trichotomum* (Driedoring) species (Hoffman (1996b).

To the west of the possible transfrontier Onseepkans area the Upland Succulent Karoo (Vegetation type 56) is occurring (Hoffman 1996c)(Figure 1). The topography ranges from gently undulating to steeply rolling, and large granitic boulders often dominate the landscape. Elevation ranges from 300 to 1 700 m. According to Hoffman (1996c) the *Aloe dichotoma* (Quiver Tree / Kokerboom) characterises much of this vegetation while other succulents species, particularly within the Vygie family (Mesembryanthemaceae) are the dominant shrubs. Grasses are generally not common but many annuals occur in this vegetation type.

Conservation Status

Edwards (1974) reported that none of the Namaqualand Broken Veld (Veld Type 33) is conserved. With the proclamations of the Richtersveld National Park and the Northern Cape Helskloof Nature Reserve some of this Veld Type is conserved.

The Augrabies Falls National Park is the largest conservation area within the Orange River Nama Karoo. The Orange River Nama Karoo consists of 537 081 km^2 of which 1.47 % is conserved (Hoffman 1996a).

The Bushmanland Nama Karoo consists of 831 942 km^2 of which 0.03% is conserved (Hoffman 1996b). This vegetation type is very poorly conserved, with no major conservation areas occurring in this vegetation type. Unfortunately, there is evidence of overgrazing in many areas. Riverine areas are seriously invaded by Mesquite tree (*Prosopis glandulosa*) and Driedoring (*Rhigozum trichotomum*) mainly in areas which are heavily grazed (Hoffman 1996b).

The Upland Succulent Karoo consists of 386 727 km^2 of which more than 4.39% is conserved. Several conservation areas such as the Goegap Nature Reserve and Richtersveld National Park occur in the Upland Succulent Karoo (Hoffman 1996c).

The *Ziziphus mucronata* Closed Woodland is strongly associated with the Orange River. According to Bezuidenhout (1996) this major community is endangered and if this plant community is not properly conserved and cared for, it will come under increasing threat particularly in the light of expanding irrigation operations along the Orange River.

In Augrabies Falls National Park, Bezuidenhout (1996) noted the absence of young *Aloe dichotoma* specimens. This was also observed in the Richtersveld National Park by a number of people (Bezuidenhout; Jürgens; Williamson, *pers. observations*). If this *Aloe dichotoma* "forest" of Acocks (1988) occurs in the proposed Onseepkans area it is definitely worth conserving.

Reconnaissance Method

Assessment of all available literature and maps. A 4X4 route through the Areas were undertaken during 11 - 15 August 1997. Notes as well as GPS references of interesting features were taken.

B. Results of Reconnaissance

Area A

Although nine different land types were recorded in the area, they are grouped into three major types:

(i) The *A land type* which refers to yellow and red soils with freely drained soils. The main geology of this land type consists of migmatite, gneis and granite predominantly; small outcrops of ultrametamorphic rocks in places. Occasional small seif dunes; dorbank at many places; very subdendritic drainage and dissection pattern, occasional lime nodules and calcrete. A terrain form sketch also indicates the relatively flat to slightly undulating nature of this landscape (Figure 4(i)). An interesting observation on the occurrence of the *Aloe dichotoma* (Kokerboom/Quiver Tree) Woodland in this area was made. The *Aloe dichotoma* Woodland seems to associate closely with the Ae and Af land types (Figure 3). The geology differs slightly from the other A land types in that there are "recent" sand deposits on the pedisediments with rare outcrops of gneissic granite and ultrametamorphic rocks of the Namaqualand Metamorphic Complex.

(ii) The *F land type* is intended to accommodate pedologically young landscapes that are not predominantly rocky and not predominantly alluvial or aeolian and in which the dominant soil forming processes have been rock weathering, giving rise typically to lithocutanic horizons. The geology consists of gneissic granite and other ultrametamorphic rocks of the Namaqualand Metamorphic Complex. The terrain form sketch indicates a rolling landscape (Figure 4(ii)).

(iii) The *I land type* refers to a land type with exposed rock (exposed country rock, stones or boulders) covering more than 60% of the area. The geology and the terrain form sketch of this land type is similar to that of the F land type (Land Type Survey Staff 1986).

During the reconnaissance survey it was noted that the Bushmanland Nama Karoo vegetation type occurs more to the north than was described by Hoffman (1996b) and definitely occurs in Area A. Typical Bushmanland *Parkinsonia africana* Woodland occurs in this area. The *Aloe dichotoma* Woodland is also typical of the Bushmanland vegetation type. The land type maps of the area (2818 Warmbad & 2820 Upington - Land Type Series 1986 & 1983) also strengthen this hypothesis (Land Type Survey Staff 1986 & 1987) since the Orange River Nama Karoo strongly relates to the F and I land type while the Bushmanland Nama Karoo strongly associates with the A land type of this area (Figure 3).

The *Aloe dichotoma* Woodland near Onseepkans, on the Kakamas road, is a healthy Woodland with young, middle-aged and old species occurring in this population (Figure 3). A few old ones were dead but there were more than enough young ones to replace the dead ones. Three other *Aloe dichotoma* Woodlands where also visited. On the Pofadder - Onseepkans road about 20 km out of Onseepkans a relatively young population were recorded with quite a number of dead old trees and little medium-aged trees. About 4 Km southwest of Pella a very young population with very little medium-aged and old species were observed. At Klein-Pella an *Aloe dichotoma* Woodland was also visited but this population has lots of old dead trees and did not look very healthy. The conclusion is that the *Aloe dichotoma* Woodland near Onseepkans is in an exceptionally good condition.

Problems areas

Riverine areas and big drainage lines are seriously invaded by the Mesquite tree (*Prosopis glandulosa*). Small scale mining of granite and rose quarts were also noted. The biggest problem in Area A is the clearing of the "natural" vegetation to produce vegetables, fruit (grapes) and lucerne.

Area B

This area is very similar to that of the Richtersveld National Park and after the reconnaissance it is felt that the Upland Succulent Karoo is more to the east than described by Low & Rebelo (1996). It was also noted that the Bushmanland Nama Karoo is occurring in this Area. There is a well-developed 4X4 Namakwa route which stretches from Pella to Vioolsdrif.

Problems areas

Riverine areas are seriously invaded by Mesquite tree (*Prosopis glandulosa*) but at Witbank and Goodhouse much of this Mesquite Trees were cleared. About 70 - 90 % of the area is community owned similar to the Richtersveld Region. Mining of granite as well as tantalum and Mica were also noted. Clearing of "natural" vegetation to produce vegetables, fruit and lucerne. Settlements like Witbank, Klein Pella and Pella the communities will have to be accommodated when looking at a possible National Park.

Concluding remarks

Although three vegetation types occur in Area B compared to the two vegetation types in Area A, the latter remains relatively undisturbed. Apart from the two or three large developments next to the Orange River, no settlements such as Witbank and Klein Pella were noted. The unique *Aloe dichotoma* Woodland is also worth conserving. The possibility of linking AFNP with Area A makes this proposition worth investigating more thoroughly. With Richtersveld National Park, Goegap and Helskloof Nature Reserves already representing the Upland Succulent Karoo there is a much greater need to conserve the Bushmanland Nama Karoo. A larger area of the Bushmanland Nama Karoo is occurring in Area A than in Area B. The area is also unique in that the Bushmanland penetrates close to the Orange River.

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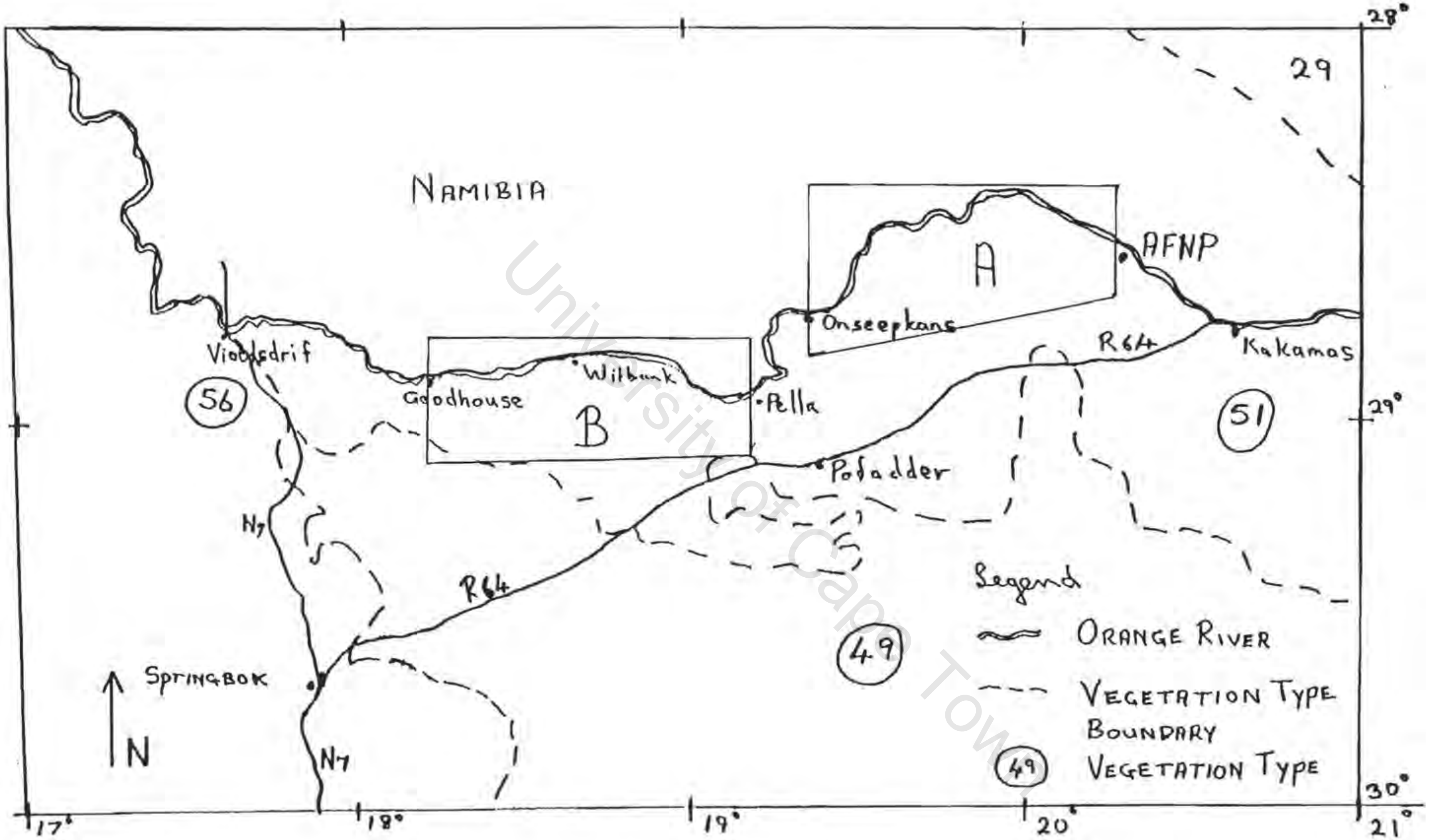


Figure 1. The two reconnaissance areas and the vegetation types occurring in the possible transfrontier national park in the Onseepkans area (Adapted from Low & Rebelo 1996).

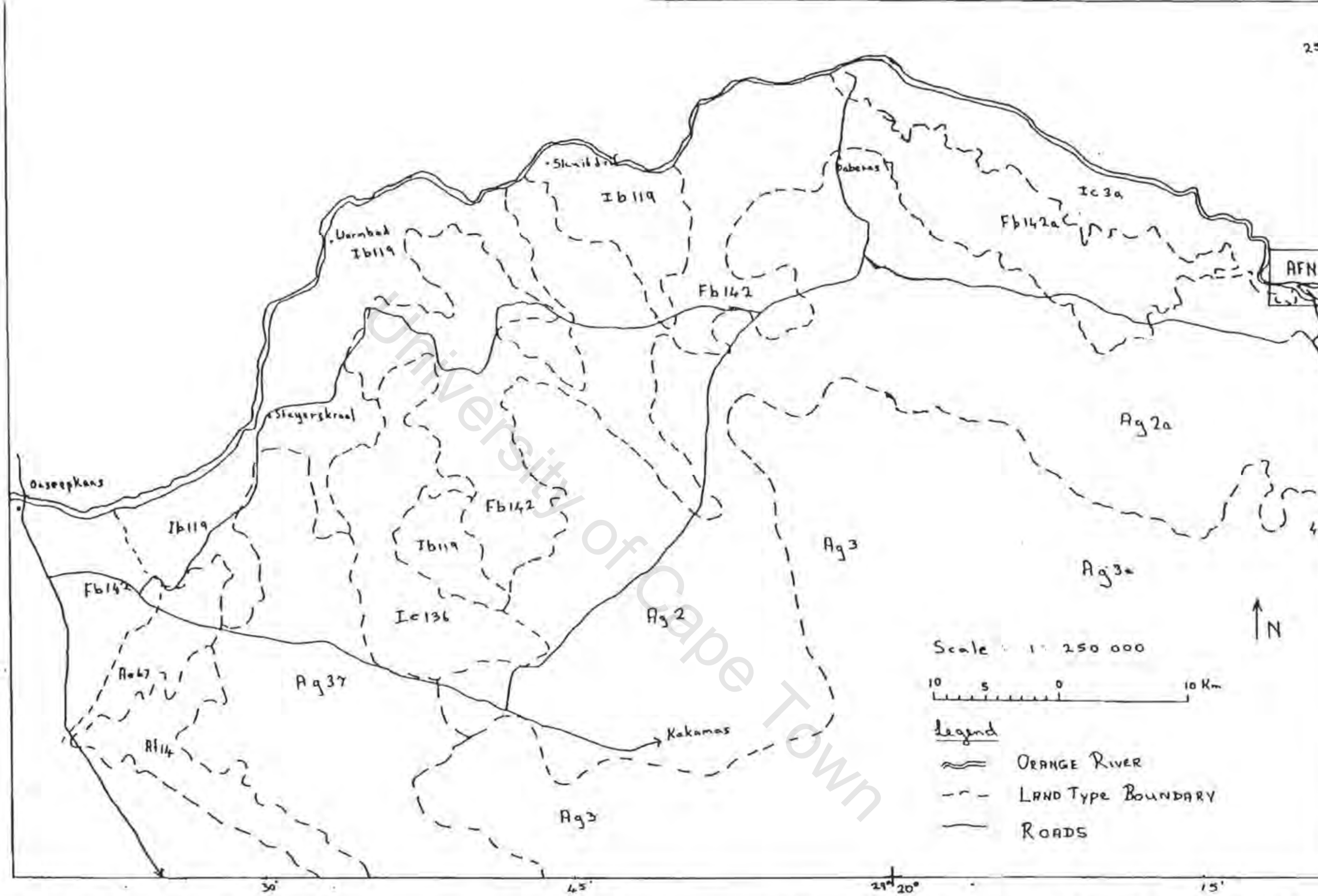


Figure 2. The land types occurring in Area A of the possible tranfrontier national park in the Onseepkans area (Adapted from Land Type Series 1983 & 1986).

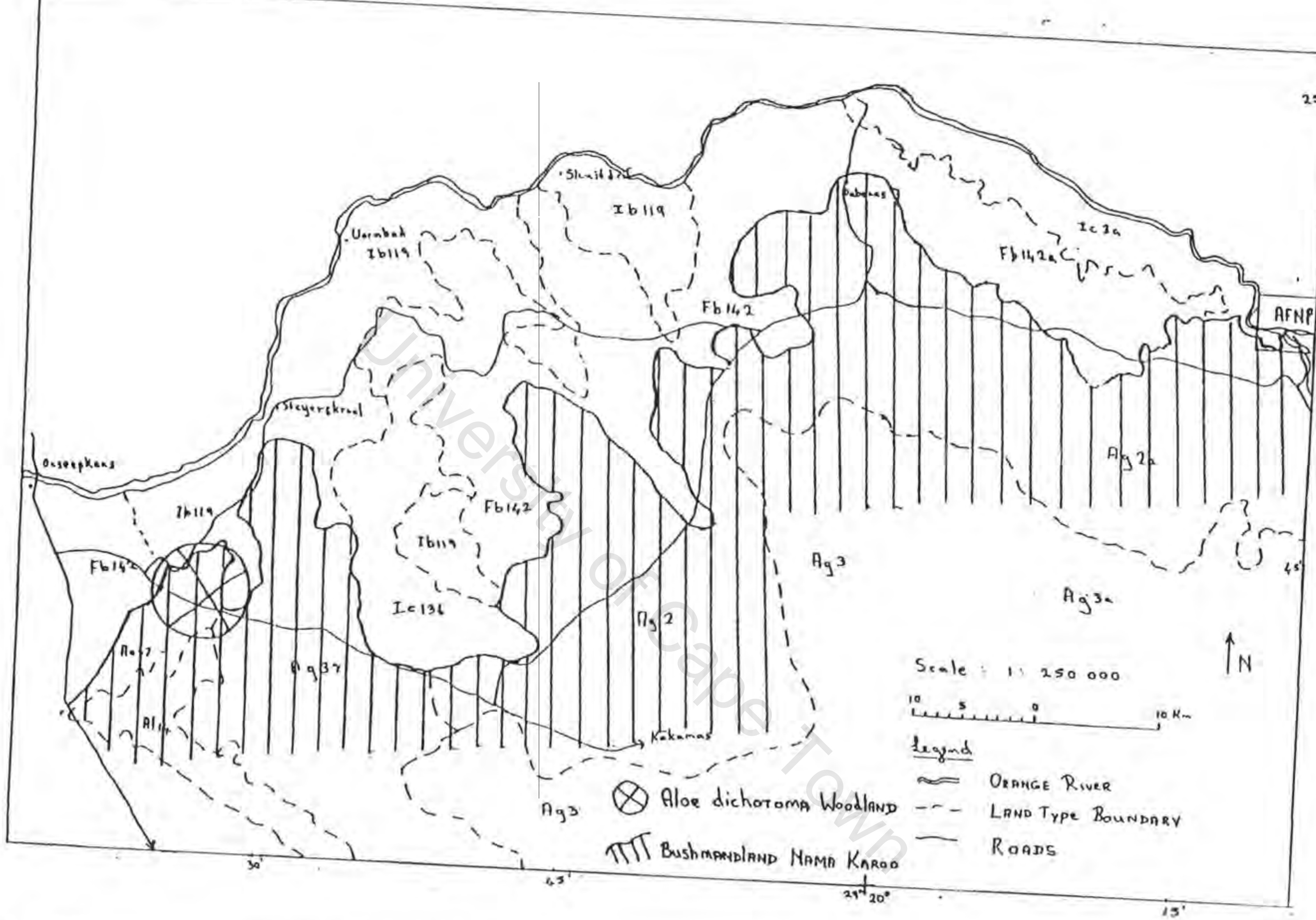
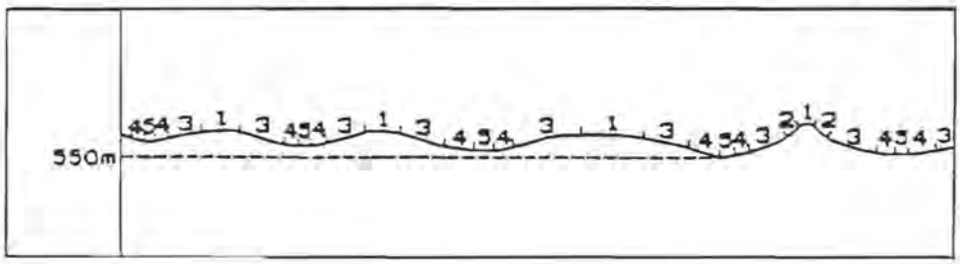


Figure 3. The healthy *Aloe dichotoma* (Kokerboom) Woodland near Onseepkans as well as the Bushmanland Nama Karoo vegetation type in Area A.

(i)

Terreintipe/Terrain type : A land type
Terreinvormskets/Terrain form sketch :



(ii)

Terreintipe/Terrain type : F & I land types
Terreinvormskets/Terrain form sketch :

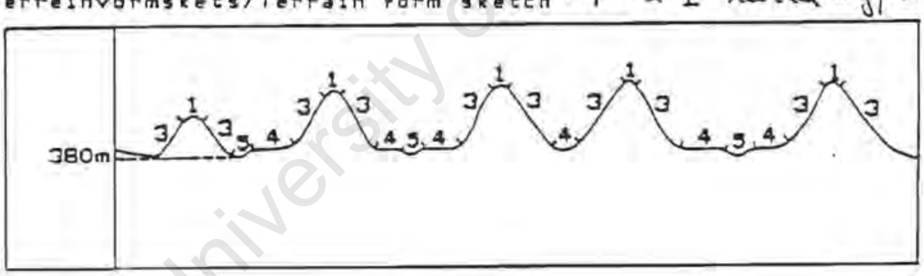


Figure 4. A terrain form sketch of the three major land types occurring in Area A (Land Type Survey Staff 1986).

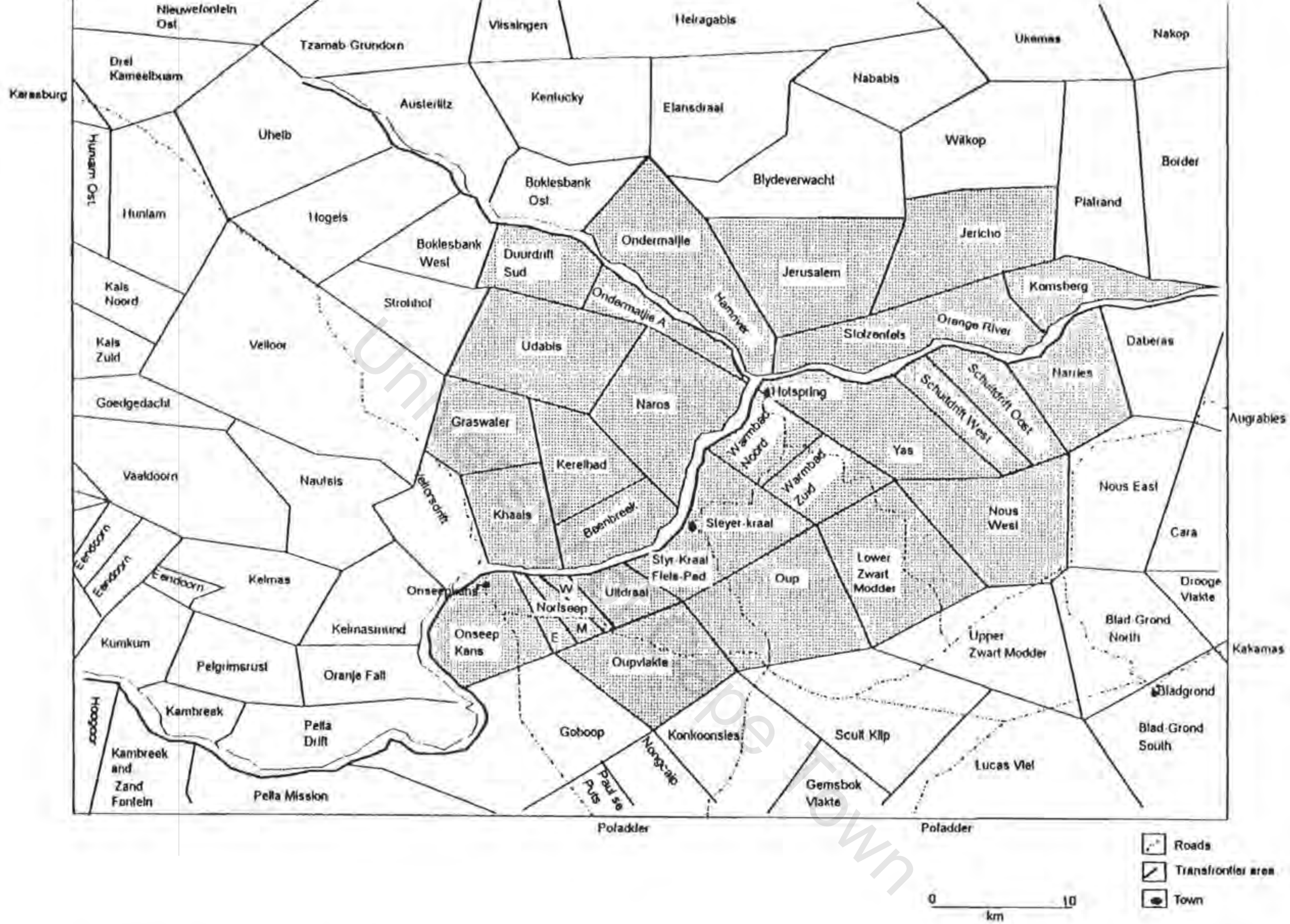


Figure 5. The possible transfrontier national park area worthy of conservation in the Northern Cape of South Africa and southern Namibia.